



industry and environment

ISSN 0378-9993
Industry and Environment
Volume 18 No. 1
January - March 1995

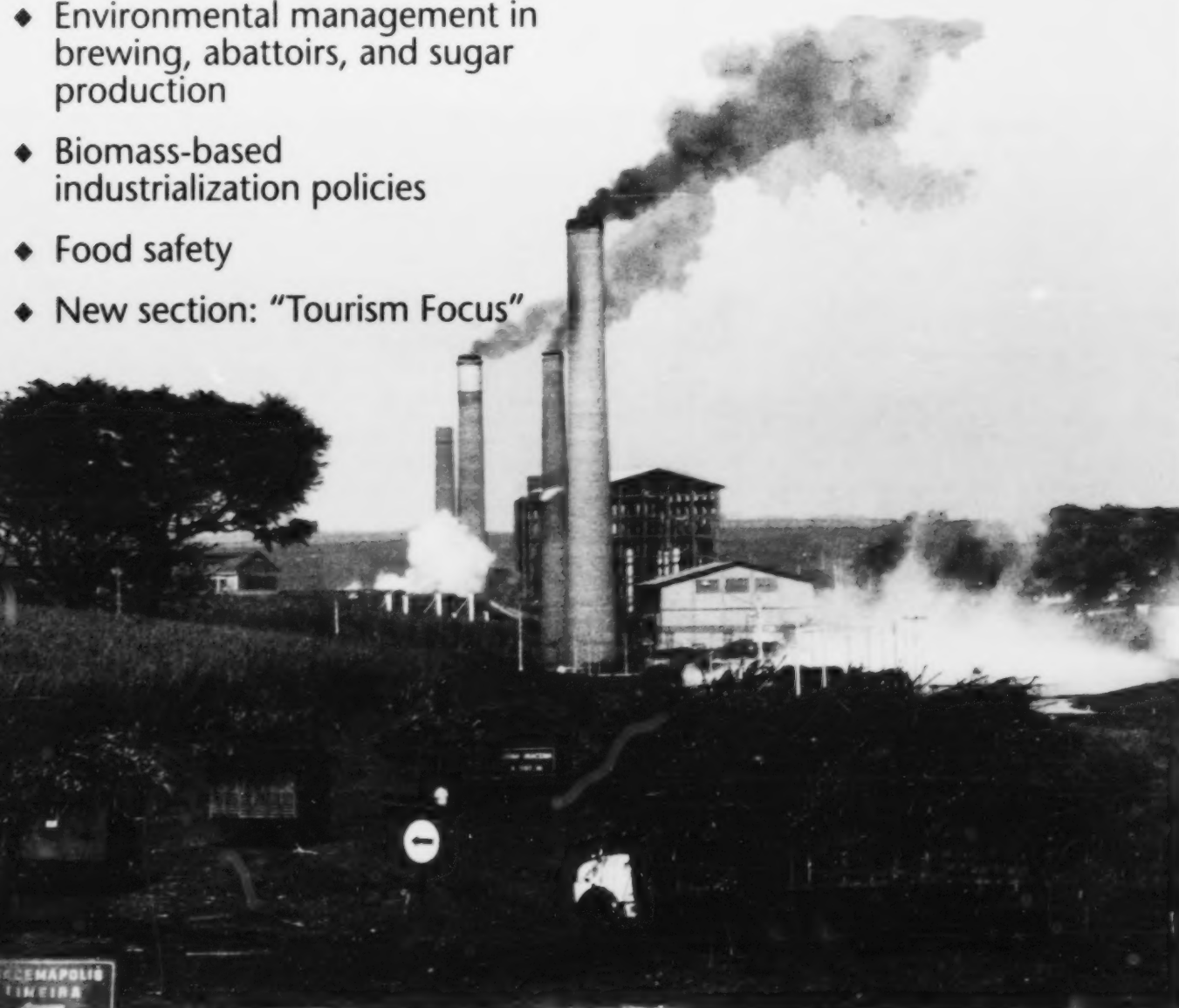
A publication of the United Nations Environment Programme
Industry and Environment - UNEP IE

Une publication du Programme des Nations Unies pour l'Environnement
Industrie et Environnement - PNUÉ IE

Una publicación del Programa de las Naciones Unidas para el Medio Ambiente
Industria y Medio Ambiente - PNUMA IMA

Food processing and the environment

- ◆ Cleaner production in food processing industries
- ◆ Environmental management in brewing, abattoirs, and sugar production
- ◆ Biomass-based industrialization policies
- ◆ Food safety
- ◆ New section: "Tourism Focus"



Contents

Industry and Environment is a quarterly review published by the United Nations Environment Programme, Industry and Environment (UNEP IE), Tour Mirabeau, 39-43 quai André-Citroën, 75739 Paris Cedex 15, France. Tel +33 1 44 37 14 50; Fax +33 1 44 37 14 74; E-mail: unepie@unep.fr.

Director

Jacqueline Aloisi de Lardere

Editorial Board

Tore Brevik
Michael Chadwick
Ossama El-Kholy
Claude Fussler
Nay Htun
William H. Mansfield III
Haroldo Mattos de Lemos
William O'Keefe
Arsenio Rodriguez
Léon de Rosen
Sergio C. Trindade

Editorial Staff

Françoise Ruffe
Nick Rowcliffe
John Smith
Thalia Stanley

Editorial Policy

The contents of this review do not necessarily reflect the views or policies of UNEP, nor are they an official record. The designations employed and the presentation do not imply the expression of any opinion whatsoever on the part of UNEP concerning the legal status of any country, territory or city or its authority, or concerning the delimitation of its frontiers or boundaries.

The non-copyrighted contents of this review may be reprinted without charge provided that **Industry and Environment** and the author or photographer concerned are credited as the source and the editors are notified in writing and sent a voucher copy.

Industry and Environment welcomes for possible publication feedback from readers, news on their sectors of activity, or articles. The editors cannot guarantee publication nor return unsolicited manuscripts, photographs and artwork. Manuscripts which do not conform to the conventions and standards of the review will be returned for revision.

Subscriptions

Industry and Environment is subject to an annual subscription fee of US\$45.00 surface mail/US\$60.00 air mail. See back page for order form. Upon application to the Director, submitted on letterhead, the annual subscription charge may be waived primarily for government, educational and non-profit organizations, particularly in developing countries, who are unable to remit payment.

This review is printed on recycled paper.

Contents

◆ Food processing

- 4 Facts and figures: food processing and the environment
- 8 Introduction to cleaner production assessments with applications in the food processing industry – *by René van Berkel*
- 15 Cleaner production activities at the Environmental Management Institute in Beijing – *by Ning Duan*
- 16 Environmental adequation of a sugar and alcohol mill in Brazil – *by Guilherme de Faria Barreto, Humberto E. S. de Mello, and Bruno Garzon*
- 19 More food, less waste in seafood processing – *by Erik Andersen and Claus Jeppesen*
- 23 Cleaner production at the Fuyang General Distillery in the People's Republic of China – *by Jiang Yongqiang*
- 27 Chlorine compounds, food safety and the environment – *by Robert L. Garfield*
- 28 Environmental imperatives and economic development: the Del Monte Philippines success story – *by I. R. Sau Obara*
- 31 Air emissions and food processing – *by Anne G. Giesecke*
- 32 Panorama de la lutte contre la pollution dans les abattoirs – *by Pierre-Yves Allard*
- 36 The food processing industry and the environment in Africa – *by S. G. Kionga-Kamau*
- 37 Aplicación de las tecnologías limpias en la industria láctea – *by Ricardo F. Luna*

◆ Other topics • Autres sujets • Otros tópicos

- 39 Nepal: rapid industrialization with minimum environmental damage – *by R. B. Shrestha*
- 45 A note on public policy and innovation in the biomass based industrial sector: lessons from the sugarcane industry in Brazil and India – *by Pierre Audinet*
- 50 Pollution prevention strategy at an H-acid manufacturing unit – *by N. Venkatesan and A. K. Saxena*
- 54 Viewpoint – *by Otto Soemartono*

◆ Tourism Focus • Tourisme • Turismo

- 56 Australia's national ecotourism strategy – *by Barbara Jones and Tanya Tea*
- ◆ Tourism news
- 58 Sports and environment – a perfect match
- 58 "Going green makes cents"
- 58 Partnerships for progress
- 58 Publications
- 58 Workshops and Meetings

◆ News • Actualités • Actualidades

- ◆ World news
- 59 Japan's policy for industry and environment
- 59 Environmental Protection in Korea, 1994
- 59 "Second generation" waste minimization programme launched
- 61 Canadian province paint recycling programme
- 61 Canadian Environmental Technology Advancement Centres
- ◆ Industry updates
- 61 The Climate Change Debate: Seven Principles for Practical Policies
- 61 One million dollars awarded for waste treatment solution
- 61 Teaching and research for cleaner production at the International Institute for Industrial Environmental Economics
- 63 The corporate environmental executive
- ◆ UNEP focus
- 63 Cooperation established on environmental assessment
- 64 Expert meeting held on marine pollution from land-based sources
- 64 UNEP and UN DHA join forces to create an environmental disasters unit
- 64 UNEP IE update
- 66 **UNEP IE in the regions**
- 66 UNEP ROAP ODS Officers Network for Southeast Asia and the Pacific
- 67 Books and Reports

◆ Sections • Rubriques • Secciones

- 79 Aware
- 81 Feedback

Food processing and the environment

Food production is an essential ingredient for human survival. The supply of food will determine the earth's population carrying capacity. Yet today, while world population increases rapidly, three major world food supply systems are showing signs of stress. The world fish catch is declining, and the Food and Agriculture Organization reports that all 17 major oceanic fishing areas are now being fished at or beyond capacity. Unsustainable use of the world's croplands and rangelands is resulting in a decline of 12 per cent in per capita grain production and a levelling off of per capita meat production worldwide. Meanwhile, from 1978 to 1991 per capita irrigated area for agriculture dropped more than five per cent, leaving a dwindling amount of irrigated land per person. There are indications that food production and food processing will become increasingly critical human activities in the years ahead, and that we will need to make them more efficient and less wasteful.

Industrial processing of food and drink, the theme of this issue of *Industry and Environment*, is part of a larger web of economic activity, reaching back to agriculture and forwards to food products, packaging, transport and consumer waste management. Environmental issues arising out of all these areas must be considered in an integrated manner by companies operating in the food sector, which has long been one of the world's largest industries.

In Europe, the food and drink sector (including tobacco) was the largest manufacturing sector in the then European Community in 1991 (with a turnover of ECU 434 billion), and the second largest in terms of employment (2.5 million workers). The pattern is similar in poorer countries. In Bangladesh, the food industry employs about 30 per cent of the industrial labour force and accounts for 25 per cent of industrial production. In Indonesia, an estimated 10 million people work in the fish processing industry alone.

The food industry worldwide contains some giant companies, but the vast majority of firms are small or medium-sized enterprises. For example, in the European Union, 1.6 per cent of food companies have more than 99 employees and account for 68 per cent of the sector's turnover; 92 per cent of companies have fewer than 20 employees and account for 15 per cent of turnover. This has important implications for governments seeking options to help the food industry improve its environmental management.

The food industry is growing in both economic value and absolute production, and will continue to do so because of the increasing world population. The Commission on Sustainable Development recently noted that agricultural production may need to double by 2025 to meet this growing demand. Changing patterns of food production and distribution will also be important. Urbanization will see to that. Only 50 years ago, countries such as France had rural populations in excess of 50 per cent of total population. Now only a small percentage of the population is rural, and this is also the trend in many countries with rapidly developing economies. Urbanization radically changes the way food is processed and distributed.

Another important factor is income. The experience of industrialized countries, and of many countries with rapidly growing economies, is that consumption of processed and packaged food rises rapidly once certain average income thresholds have been crossed. Simultaneously, consumers in industrialized countries have increasingly rejected "junk" foods in favour of healthier diets.

It is not the purpose of this issue of *Industry and Environment* to address the issue of a sustainable food industry. However, it is a question that we all, and the food industry in particular, should bear in mind. If agricultural production cannot continue to keep pace with population growth, then the food industry will have an important role to play in increasing the efficiency of the food processing and distribution chain.

Of course, increased efficiency of production must be a major goal for the food industry in any case. It will have to reduce pollution and waste, and increase the efficiency with which it uses energy and raw materials, including water. Food processing is not considered to be amongst the most

environmentally hazardous industries, as pollution from food processing is mostly organic and generally has a local rather than regional or global impact. Nevertheless, food processing plants can cause severe pollution if designed or operated with insufficient attention to the environment.

Three environmental problems common to all food processing sectors (fish, meat, vegetables and fruits) are: high water consumption, especially problematic in arid countries; the generation of liquid effluent with high organic content; and the generation of large quantities of sludge and solid waste.

One environmental challenge for the food industry is to reduce waste generation at source. Another is to find ways to reuse waste streams that are unavoidably generated. More efficient processing technologies can play a substantial role in achieving this. The emerging biotechnology industry could assist in waste reduction efforts, through improved processing and the creation of foodstuffs that have a better yield when processed (for example, potatoes bred to contain higher starch levels).

Food contamination is becoming an increasing concern. It can occur due to poorly controlled processing, or inappropriate packaging, or during distribution. It can also result from environmental pollution from other sources. Examples include the pollution of water supplies to food processors, contamination of foodstuffs with heavy metals deposited from the atmosphere, and pesticide contamination due to the inappropriate use of agrochemicals, as highlighted by a UNEP publication, *The Contamination of Food*. These problems demonstrate the strong interlinkages between food production and other parts of the economy, such as agriculture, packaging and distribution.

While environmental issues related directly to food processing can be serious, most can be solved in a relatively simple way. Water use can be drastically cut through in-house recirculation systems. High organic load wastewater can be effectively treated to digest its biological content, greatly reducing its polluting potential. Avenues are also being explored to reuse liquid and solid wastes produced from food processing.

To solve these and other environmental problems, the food industry should adopt cleaner production methods. Studies have shown that food processing companies often waste proportionately more raw material, energy and water than other industry sectors. These studies have also found that fairly simple technical measures can reduce the wastage. Articles in this issue of *Industry and Environment* demonstrate the potential for environmental improvement in food processing through implementation of cleaner production.

As the food industry produces more processed and packaged food, a variety of product-related environmental issues are growing in importance. The environmental impact of the transport of food needs to be considered; life-cycle analysis studies have shown that transport can account for a very significant portion of pollution generated over the life-cycle of packaged food products. The post-consumer waste implications of changing patterns in packaging should also be addressed. The management of packaging waste has already become an important political issue in many developed countries, and the food industry has found itself at the forefront of the debate. In countries such as Germany, the food industry, along with other industrial packagers, already shoulders a significant financial burden for managing the waste resulting from its packaging. Another product issue requiring close attention is that of contaminant migration from packaging to foodstuffs.

Overall, the world food industry must walk a tightrope if it is to achieve environmental sustainability. Production will have to increase to meet the needs of a growing population. But the efficiency with which the industry uses all raw materials will have to increase by a considerably larger margin if the environmental burden from food processing activity is not to become unsustainable. ♦

Food Processing

Facts and figures: food processing and the environment

The food industry is one of the world's largest industrial sectors. In some countries and regions, it is the largest single manufacturing industry sector (Figure 1). As shown in Table 1, trade in food is also very substantial, especially amongst developed countries. In fact, developed countries account for about three-quarters of the value of food exports and imports, while containing well under half of the world's population (Table 2).

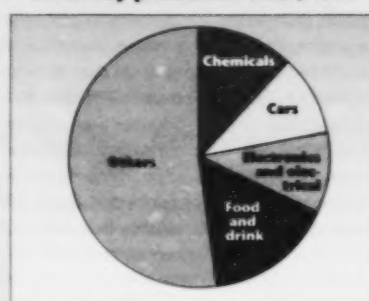
The disparity is accounted for by the greater purchasing power of developed country consumers, and by the ever greater economic importance of secondary and tertiary processing in the food industry. As populations grow richer, they tend to buy ever more processed food. This phenomenon has historically been confined almost entirely to the presently developed countries. However, sales of processed food are expected to climb rapidly in many fast-developing countries as their populations reach critical levels of average income (Figure 2).

Food processing includes many activities, ranging from the basic washing of fruits and vegetables destined for sale as fresh produce to secondary processing for the manufacture of pre-prepared meals. By way of example, Figure 3 shows the structure of the food industry in the European Union, in which many different types of processes are involved. Even in the case of basic processing activities, food processing can involve a complex chain of interactions, as shown for the meat industry in Figure 4.

The food processing industry is not a concentrated one in comparison with many other industrial sectors, including in developed countries. In 1988, over 92 per cent of food businesses (the statistics also include drink and tobacco) in the 12-member European Community had fewer than 20 employees. Nevertheless, world-scale multinational companies have emerged in the food sector (Table 3) and play a role in the industry greater than their relatively small number would suggest. In 1988, only 1.6 per cent of EC food, drink and tobacco companies had more than 99 employees. But these firms accounted for over 68 per cent of the sector's turnover.

Environmental issues in the food processing industry are diverse. One of the main issues is wastewater prevention and treatment (Table 4). Wastewater in the food industry varies a great deal with the material, and the kind and degree

Figure 1
European Union manufacturing sectors by production value, 1991



Source: Confederation of the Food and Drink Industries of the EC.

**Processed food output 1990:
20 largest countries
(US\$ billion)**

1 USA 104	11 Australia 8
2 Japan 75	12 Belgium 7
3 Germany 34	13 South Korea 6
4 France 26	14 Austria 5
5 UK 18	15 India 4
6 China 17	16 Thailand 4
7 Italy 15	17 Argentina 4
8 Brazil 14	18 Indonesia 4
9 Mexico 10	19 Philippines 4
10 Netherlands 9	20 Denmark 4

Source: The Economist World in Figures 1993.

Table 1
Food imports and exports by world region, 1992

	US\$ billion	
	Imports	Exports
Developed countries	195.1	180.8
North America	22.9	40.8
Europe	135.3	126.4
Oceania	1.6	10.5
CIS	12.6	0.4
Other developed	22.6	2.8
Developing countries	66.8	57.1
Africa	9.8	4.6
Latin America	14.0	21.6
Near East	16.8	5.8
Far East	25.5	24.7
Other developing	0.8	0.4

Source: UN Food and Agriculture Organisation.

of processing. It is commonly characterized by a high concentration of organic matter, a high concentration of semi-solid wastes, and large seasonal fluctuations. In the potato starch industry, some factories produce 100,000 to 250,000 m³ of starch-containing sludge annually. In the vegetable sector, up to one-third of the total quantity of raw materials processed may be rejected. Washing water, sometimes at high temperature, is discharged in large volume. Since in principle no harmful substances such as heavy metals are mixed in wastewater, excess sludge generated by wastewater treatment can be dehydrated and recovered as a resource for manure or livestock feed. Another avenue for reuse of food industry sludges and scraps is anaerobic digestion to produce biogas (Figure 5).

Although food processors try to avoid the use of toxic substances because of the nature of their product, contamination of food products can nevertheless be a problem (Figure 6). A UNEP monitoring programme has found high concentrations of metals such as lead and cadmium in staple foods and water in industrialized areas of Europe and North America. Similarly, polychlorinated biphenyls (PCBs) and mercury have been found in high concentrations in some regions, mainly due to local water pollution. Other potential sources of food contamination are poor storage and inappropriate packaging.

Air pollution can also be a problem in some food processing operations. Volatile organic compounds, which are implicated in the formation of low-level ozone and smog, are produced by bakeries as well as by frying and grilling in restaurants. Restaurants in the Los Angeles region have been estimated to emit 19 tonnes of organic compounds a day: as much as the region's major oil refineries.

For food companies operating in developed countries, and increasingly in developing countries, too, downstream issues such as packaging and post-consumer waste management are of growing importance. Food and drink packaging makes up a significant and visible part of the municipal solid waste stream (Figure 7) and has been at the centre of the debate over ways to reduce or recycle packaging. Innovative government policies, such as Germany's Waste Packaging Ordinance, have put pressure on the food industry (along with other industrial users of packaging) to do more to reduce, reuse and recycle waste packaging. In response, most large

Food Processing

Figure 2
Income trigger points for purchases of different sorts of food

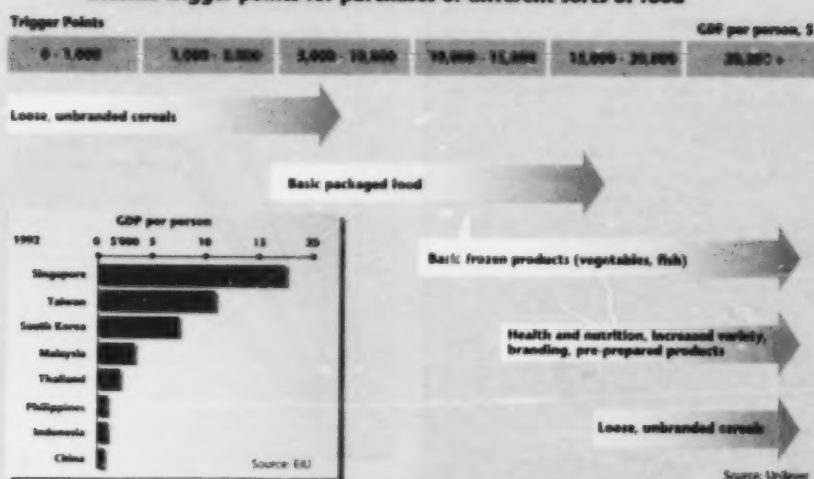


Table 3
World's 12 largest food companies, 1992

	(food sales, US\$ billion)
Nestlé	37.6
Philip Morris	33.0
Unilever	22.5
PepsiCo	13.7
Coca-Cola	13.1
BSN	12.4
Grand Metropolitan	9.7
RJR Nabisco	6.7
Sara Lee	6.6
CPC International	6.6
Heinz	6.6
Campbell	6.3

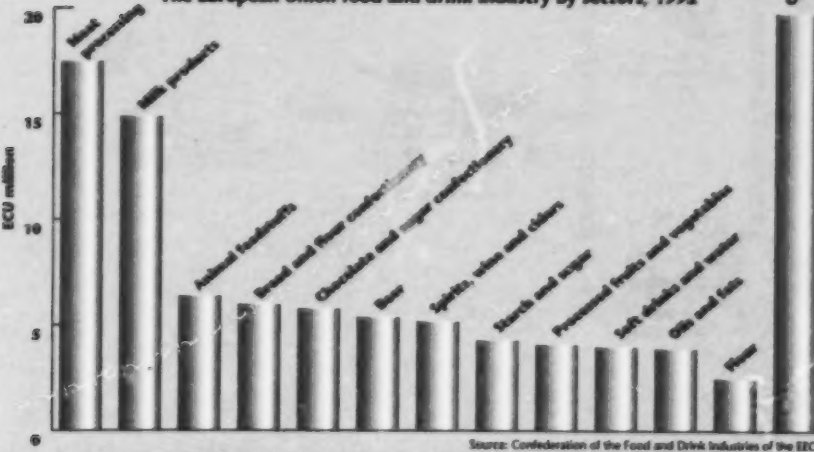
Source: Food Business

Table 2
Leading producers of food products, 1990

World leading countries % of world food production		Leading developing countries % of developing country food production	
United States	18.8	Brazil	13.9
Germany (former Western)	9.6	Mexico	10.5
Japan	9.4	Argentina	8.5
France	9.3	India	5.2
United Kingdom	4.7	Turkey	4.2
Italy	4.0	Cuba	3.7
Brazil	3.6	Republic of Korea	3.5
Mexico	2.7	Philippines	3.4
Argentina	2.2	Colombia	3.2
Belgium	2.2	Taiwan Province	3.1
Netherlands	2.1	Yugoslavia	3.0
Canada	2.0	Malaysia	2.4
Spain	2.0	Pakistan	2.3
Australia	1.7	Venezuela	2.3
Switzerland	1.5	Thailand	2.2
Total	75.8	Total	71.4

Source: UNIDO Handbook of Industrial Statistics (1992)

Figure 3
The European Union food and drink industry by sectors, 1992



food processing companies have developed policies to meet this challenge. Life-cycle assessment is increasingly being applied as a tool to achieve reductions in the amount of raw materials used, energy consumed, pollution caused, and waste produced per unit of food delivered to the consumer.

Overall, the food industry faces the challenge of significantly increasing its overall resource efficiency – obtaining the maximum of useful products from the minimum raw materials and other inputs, including energy and water. Some examples taken from different sectors of the food industry illustrate the range, and show the extent to which environmental improvements are possible.

Coconut processing, the Philippines

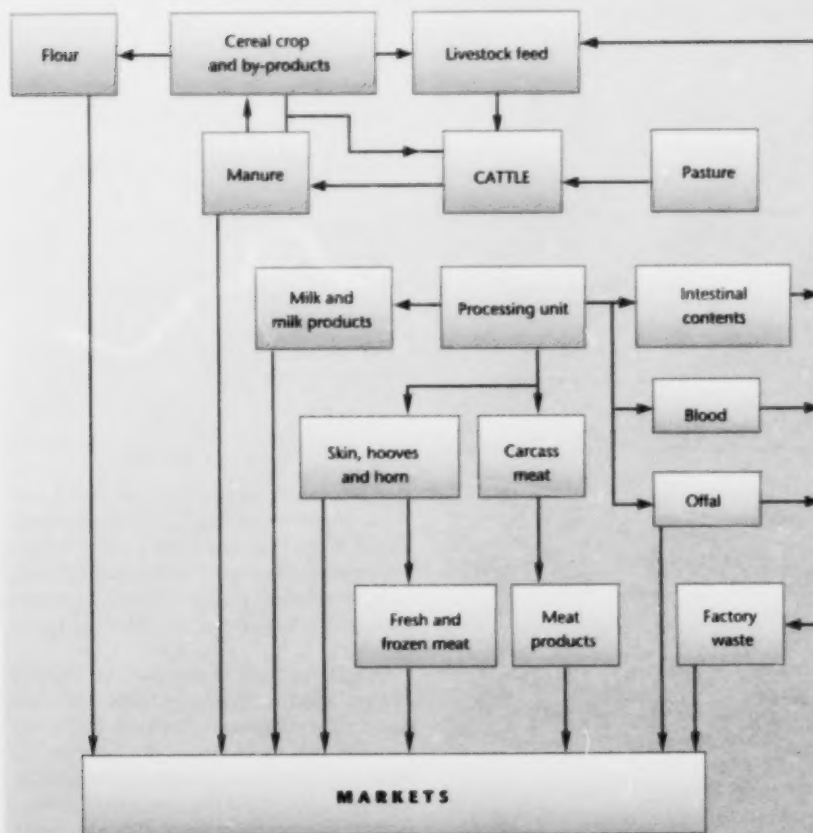
Lucena Desiccated Coconut Products (Ludesco) dries and shreds coconut meat used in food products. The production waste generated includes coconut shells, parings, sprouts, rejected coconut meat, spilled desiccated coconut, and a large volume of wastewater. The company launched a programme to improve process efficiency and reduce waste. Through this programme coconut wastage was reduced from 19 to 9 per cent at a capital cost of P 160,000; a cost that was recouped from savings in just 15 days. The company has also succeeded in reducing energy demand and wastewater generation.

Dairy, the UK

Express Foods produces cheese and whey powder used in the manufacture of biscuits, chocolates and baby food, handling up to 400,000 litres of milk daily. Waste produced at the factory has a high organic load, accounting for 80 per cent of the organic load and 60 per cent of the volume of effluent treated at the local public sewage treatment works. During the 1980s, the company was prosecuted for a pollution incident in which ammonia was released into a local river, killing thousands of fish. The incident led to a new policy of effluent reduction, leading in turn

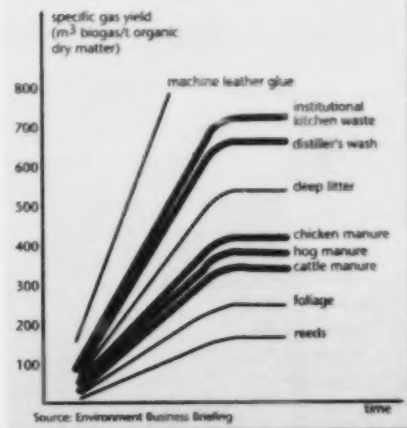
Food Processing

Figure 4
The establishment of meat processing centres



Source: Integrated Food Processing Industry in Africa: Constraints and Promotional Measures, UNIDO (1983)

Figure 5
Biogas yield from selected inputs

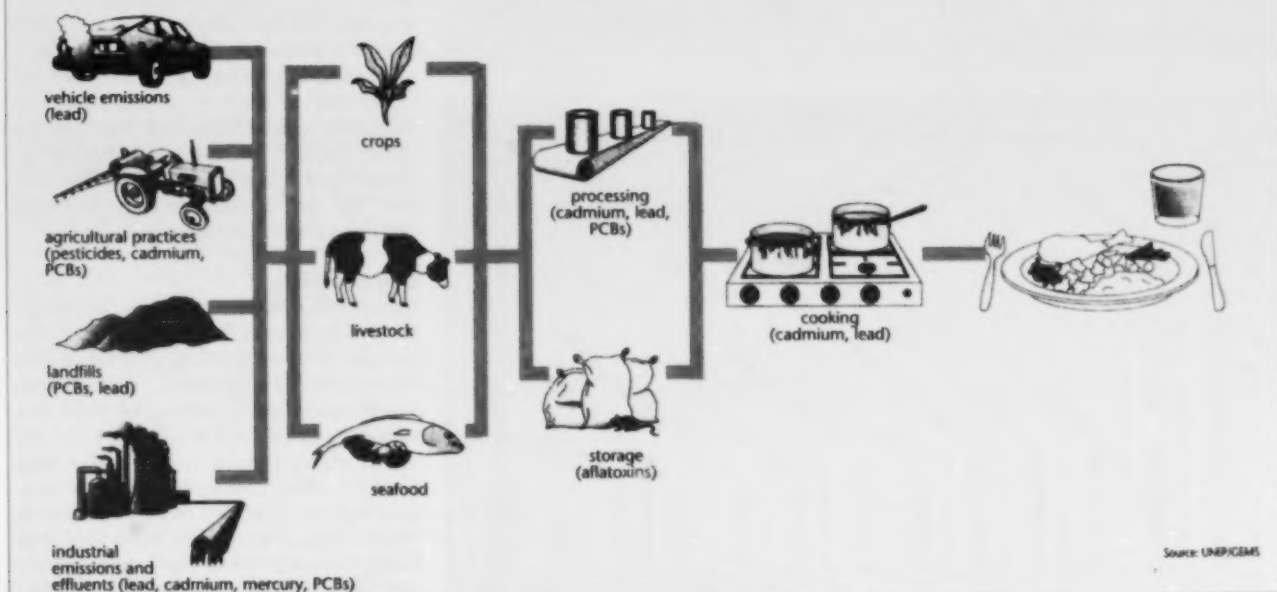


to a reduction in waste and in costs, and in 1991 to a corporate environmental award.

Beer manufacture, China

Beijing-Zhongce Beijing Beer Company produces 120,000 tonnes a year of beer in bottles, cans and barrels. Prior to an environmental improvement programme, the firm was losing nearly 10 per cent of beer during production, adding to the volume and strength of its effluent load. A range of measures were undertaken to reduce wastage, such as better control of bottle filling and improvement of checks on equipment in the plant. These initiatives have reduced beer loss, much reduced the chemical oxygen demand of the plant's effluent, and saved on labour and raw material needs. As well as protecting the environment, the initiatives are saving the plant money.

Figure 6
Common sources of food contamination



Source: UNEP/CIGM

Food Processing

Table 4
Some specific water pollutants generated in food processing

Pollutant	Functions	Key to functions:
Acetone	16	1 3..... Alkali
Methyl iso-butyl ketone	16	2 10..... Bleach
Cetyl trimethylammon. bromide	4,7	3 13..... By-product or waste product
Sodium	1,11,14	4 15..... Cationic surfactant
Chloride	1,2,3,6,8,11,14	5 Cleaner
Phosphate	3,5,9,12,13,15	6 De-icing fluid
Polyphosphate	5,15	7 Disinfectant
Silicate	1,5,10	8 Etchant
		9 Fertilizer
		10 Flux
		11 Impurity
		12 Rust inhibitor
		13 Rust remover
		14 Salt
		15 Sequestering agent
		16 Solvent

Source: Control Policies for Specific Water Pollutants, OECD (1982)

Citrus fruit packing, USA

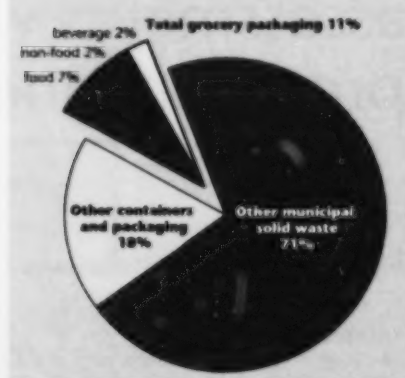
The Mount Dora Fruit Growers Cooperative represents 46 growers of oranges, grapefruit and tangerines in Florida. Prior to an environmental improvement programme, the cooperative's processing plant generated 10-20,000 gallons of waste washwater a day, arising from detergent washing, disinfection, waxing and colouring. The water generally contains residuals of cleaning chemicals, wax and oil, sand, sooty mould and fruit debris. A water pre-treatment and reuse system was installed, enabling water to be reused 20-40 times over before final discharge. This in

turn made possible a reduction in water usage by up to 19,000 gallons a day, saving the cooperative US\$ 3500 a year in water and sewage treatment costs.

Sources

Campbell Soup
Confederation of the Food and Drink Industries of the EEC
The Economist
The ENDS Report
Environmental Business Briefing
Food Business

Figure 7
Food packaging in the US municipal waste stream, 1992



Grocery Manufacturers of America
International Labour Office
Nestlé

New Scientist
Organisation for Economic Cooperation and Development
Philippines Industrial Environmental Management Project
UNEP Cleaner Production Programme
UNEP/GEMS
UN Food and Agriculture Organization
UN Industrial Development Organization
Unilever

Introduction to cleaner production assessments with applications in the food processing industry

René van Berkel, IVAM Environmental Research, University of Amsterdam, P.O. Box 18180, 1001 ZB Amsterdam, the Netherlands¹

Abstract

A cleaner production assessment aims at the identification, evaluation and implementation of CP opportunities in a company. A systematic working method, which facilitates the execution of a CP assessment, generally consists of three separate, interrelated options: method; procedure; and guidance and supervision. In addition to introducing these elements and their applications in the food processing industry, this article presents plant-level assessment results to illustrate the possible benefits of CP in various food processing sectors.

Résumé

Une évaluation de production plus propre a pour objectif d'identifier, d'estimer et de mettre en oeuvre le potentiel de production plus propre au sein d'une entreprise. Une méthode de travail systématique susceptible de faciliter une telle mission d'évaluation comporte généralement trois options distinctes mais liées entre elles : méthodologie ; procédure ; assistance et supervision. Cet article présente ces différents éléments et leur application dans le secteur alimentaire ; il rend compte également des résultats de l'évaluation au niveau des usines afin de montrer les avantages potentiels d'une production plus propre dans diverses branches du secteur alimentaire.

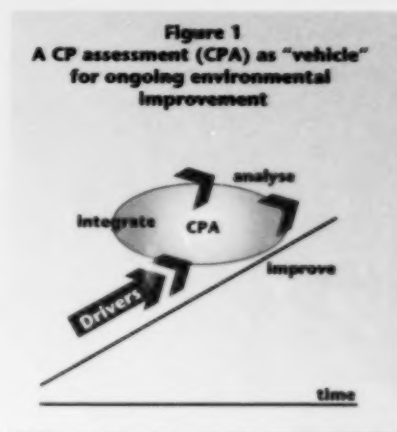
Resumen

Una valoración sobre producción limpia (CP) apunta a la identificación, evaluación y puesta en práctica de las posibilidades de CP en una empresa. Un método de trabajo sistemático, que facilite la ejecución de una valoración CP consta generalmente de tres opciones diferenciadas pero interrelacionadas: el método, el procedimiento, y las pautas y supervisión. Además de introducir estos elementos y sus aplicaciones en la industria de procesamiento alimenticio, en este artículo se presentan los resultados de una valoración a nivel de planta para ilustrar las posibles ventajas de CP en los diversos sectores de esta industria.

Cleaner production assessments

Crucial for cleaner production (CP) is the continuous application of an integrated preventive strategy to industrial processes and products in order to avoid, or at least minimize, the generation of waste and emissions. The application of this preventive mindset to existing production facilities normally results in a diversity of CP opportunities. A comparative evaluation of these opportunities is then needed, in order to exploit the economic and environmental benefits of CP. A systematic working method facilitates the development, evaluation and implementation of CP options tailored to the company's products, processes and operations.

The plant-level working method for CP, or assessment, is often characterized as a systematic planned procedure with the objective of identifying ways to reduce or eliminate the generation of waste and emissions.² Furthermore, an assessment should initiate an ongoing CP programme, catalyzing the corporate effort to achieve continuous environmental improvements in its operations. In order to emphasize the ongoing improvement process, CP assess-



ments are sometimes also referred to as "environmental improvement" cycles. Such a cycle serves three functions:

- 1) *analysis* of the environmental burden of the production processes and its causes;
- 2) inventory and evaluation of *improvement* options for the production processes;
- 3) *integration* of the feasible improvement

options into the production processes and into the daily operation of the company.

Consecutive cycles enable the company to achieve environmental improvement in key areas such as:

- *resource conservation*: improvement of the material and energy efficiency of production in order to reduce the input of natural resources (materials, energy and auxiliaries) per unit of production;

- *toxics use reduction*: reduction and – to the extent feasible – elimination of the use of "hazardous" materials. In this respect, all materials exerting a highly negative environmental impact could be considered as "hazardous" (including toxic substances, ozone-depleting chemicals, global warming chemicals, etc.).

- *waste minimization*: reduction and – to the extent feasible – elimination of the generation of "waste" materials (including by-products, solid waste, hazardous waste, air emissions and/or wastewater discharges).

The environmental improvement process is visualized in Figure 1.

A systematic working method for the execution of a CP assessment normally consists of a "method", a "procedure" and (external) "guidance and supervision".³ The *method* serves as the tool for the identification of CP options. The *procedure* organizes the necessary activities and thus fosters the development and implementation of CP opportunities. The (external) *guidance and supervision* guides, informs and stimulates the responsible assessment team at the plant level. Working methods used for the introduction of CP in the food processing industry differ for all these components. Therefore, each of them is dealt with in detail below.

Generating alternate CP options

As CP focuses on the production process that causes the waste stream, the central element of the CP method should be to examine and re-evaluate the production process. This re-evaluation consists of a "source identification" followed by a "cause evaluation" and "option generation". For the *source identification*, an inventory should be made of the material flows entering and leaving the company with the associated costs. This results in a process flow diagram, allowing for the identification of all sources of waste and emission generation.

Next is the *cause evaluation*, an investigation into the factors that influence the volume and composition of the waste and emissions generated. A checklist of possible waste generation causes is used to assess all possible factors influencing the volume and/or composition of the waste stream or emission. The checklist should correspond to the general prevention techniques. Therefore product requirements, input material specifications, technology, process execution (operating practices), and waste and emission characteristics are generally used as possible cause categories. A materials and energy balance is needed for the evaluation of the relative importance of each of the possible waste generation causes.

The purpose of the next logical step (*option generation*) is to create a vision of how to eliminate or control each of the causes of waste and emission generation. The CP approaches (or prevention techniques) specified in the conceptual framework are used to develop appropriate CP options. Once CP options have been identified, these should be evaluated like other investments or technical innovation options.

Source identification

Source identification starts with the drafting of a list of unit operations, with their associated material inputs and outputs and transformations. Production generally comprises a number of such unit operations. These can be defined as an area of the process or a piece of equipment where materials are input, a function occurs and materials are the output – possibly in a different form, state or composition. It is important to choose the right level of detail during division of the production process into unit operations. It might be wise to start with a general list, with the main unit operations, and go into details at a later stage only for those unit operations that cause serious waste generation. By connecting the individual unit operations in the form of a block diagram, one can prepare the process flow diagram. To reduce complexity, one should try to start with the raw materials at the top of the diagram and end with the final product at the bottom of the diagram. For each unit operation, material inputs are placed at the right side of the diagram and material outputs at the left side.

An essential step is checking the process flow diagram. What goes in must come out somewhere. So all inputs should have related outputs, as product or waste, and all outputs have to be traced back to inputs. All unit operations can be the source of various waste streams. Therefore, the complete process flow diagram should be used to check all unit operations for waste generation and thereby compile the list of all waste sources.

A factory producing deep-fried salted peanuts can be taken as an example.⁴ The peanuts, which are supplied in plastic bags, are emptied directly onto a conveyor belt. They are transported through a deep-frying oven; then they pass through a cooling unit; and finally they are sprinkled with

Figure 2
Sources of process waste in a factory producing salted peanuts

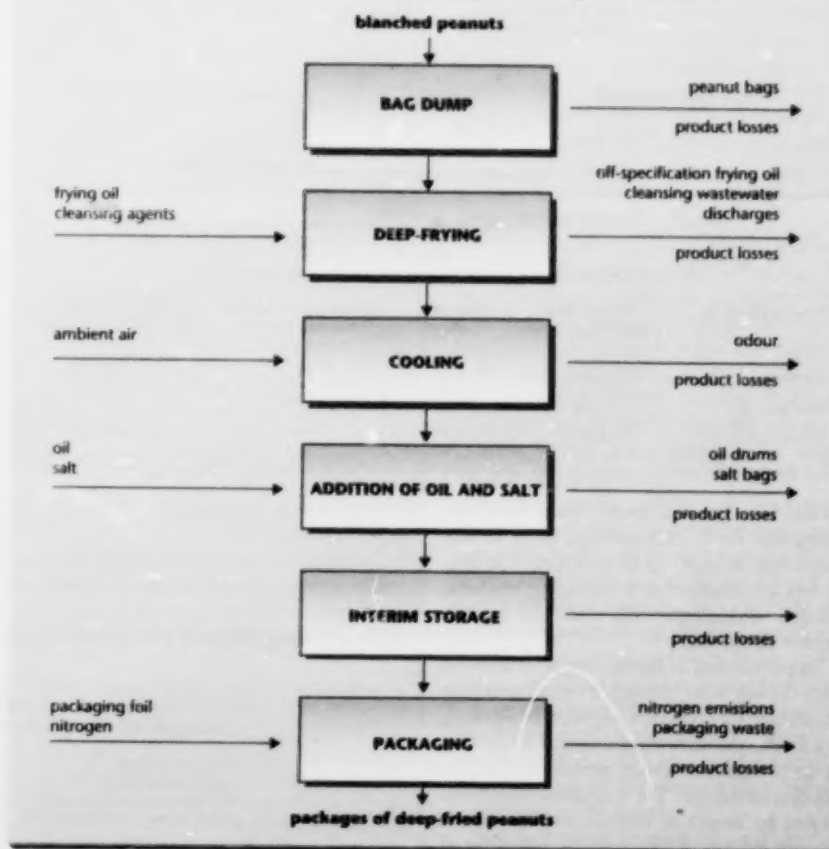


Figure 3
Cause evaluation: five possible causes of waste generation

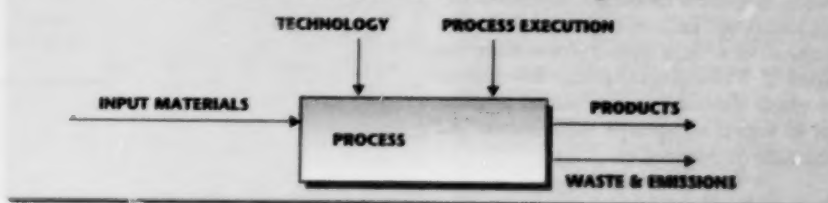
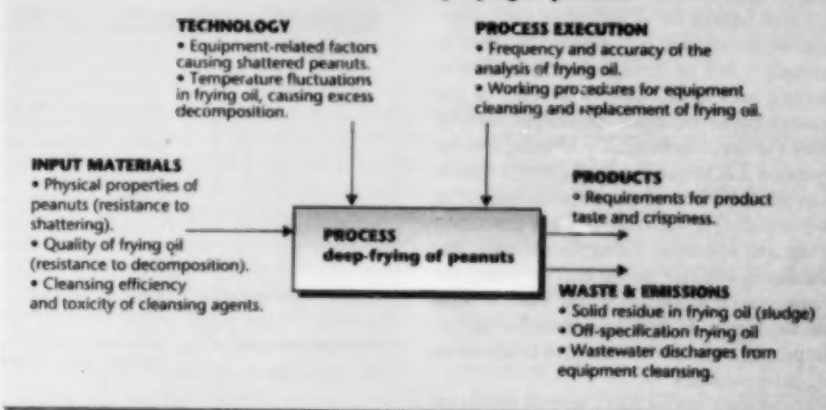


Figure 4
Cause evaluation for deep-frying of peanuts



Food Processing

Figure 5
Option generation: application of the general CP approaches

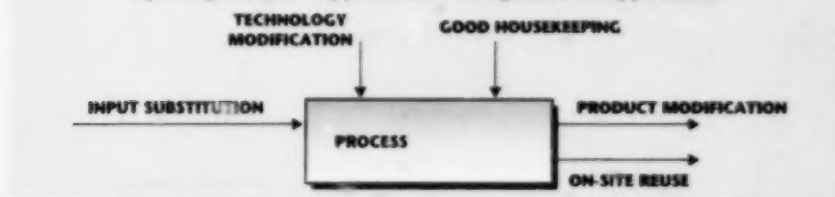


Table 1
Selection of audit focus at Beijing Brewery

Production units	Production (10,000 tonnes/yr)	Beer loss (%)	Water consumption (tonnes water/ tonnes beer)	COD discharge (kg COD/tonne beer)
Old brewery	5.82	9.25	14.2	21.8
New brewery	4.48	9.73	17.0	24.0
Factory average	10.31	9.39	15.4	10.4 (after EOP)

oil and salt. The peanuts are then poured into containers for interim storage. After several hours they are ready to be packaged. The containers are attached to a packaging machine, which forms bags from rolls of foil and then fills them with peanuts.

To prevent loss of flavour, the air is removed from the bag using nitrogen. From time to time the oil used for deep-fat frying must be replaced, as a residue gradually accumulates at the bottom of the oven (due to broken peanuts and decomposition of the oil). The deep-fried peanuts are cooled by means of outside air. The salt is brought into the plant in paper bags and the oil in metal drums.

The process flow diagram for this factory has six unit operations (bag dump, deep-frying, cooling, addition of oil and salt, interim storage, and packaging). Each unit operation is also the source of one or more types of process waste (see Figure 2). When using this process flow diagram for source identification, care should be taken not to neglect non-process waste sources like maintenance, cleansing, etc.

Cause evaluation

The next step is to evaluate all material flows. One should try to quantify the volume and composition of all material flows which could result in a mass balance for all individual unit operations or for the entire company.⁵ As there is generally a lack of detailed data, it is hard to compile such mass balances for each of the constituents of the input and output material flows. For the purpose of CP, evaluating the unit operation is as important as compiling a reliable mass balance. This evaluation should result in an understanding of the cause of waste generation at the unit operation. Generally speaking, one can distinguish five factors that influence the volume and composition of the waste streams (see also Figure 3). Following these five factors, the process evaluation should give an answer to five basic questions:

1) Do product specifications have an impact on

volume and/or composition of the process wastes and emissions?

2) Do input materials have an impact on volume and/or composition of the process wastes and emissions?

3) Do technological factors (like process design,

equipment, piping, etc.) have an impact on the volume and/or composition of the process wastes and emissions?

4) Do operating practices (like planning, workers' training and motivation, etc.) have an impact on the volume and/or composition of the process wastes and emissions?

5) Do waste handling procedures have an impact on the volume, composition, and/or recycling potential of the process wastes and emissions?

Discussions between operators, supervisors and plant management on these questions generally result in a thorough understanding of the causes of waste generation.

Once again, the application of the cause evaluation can be illustrated with the example of the peanut factory. In this factory the peanuts are dumped onto a conveyor belt which transports them at a constant speed through a frying oven filled with oil. They are deep-fried for ten minutes in this frying oil, which is kept at a constant temperature of 160 °C. Broken peanuts might fall from the conveyor belt and drop to the bottom of the oven, and this residue hastens the decomposition process of the frying oil. For this reason the quality of the frying oil is monitored every 15 minutes. If the concentration of decomposition products is too high, the process

Figure 6
Example of CP options for deep-frying of peanuts

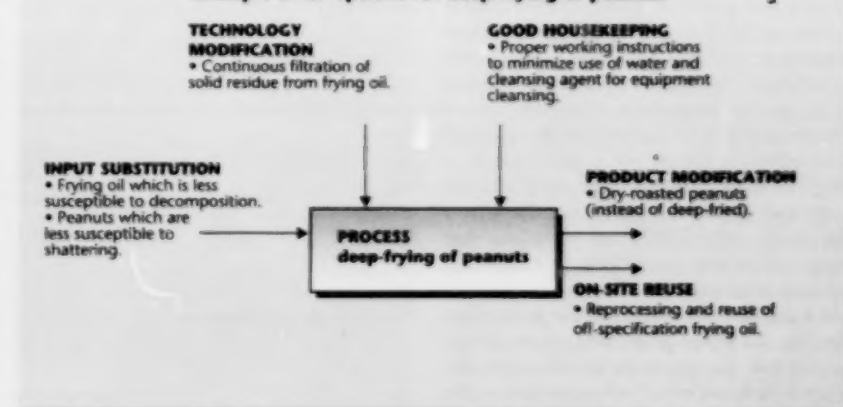


Table 2
Summary of the feasibility study results

	Yeast Recovery	Beer Recovery
Explanation	At present, the beer liquid from the fermentation is directly fed into the diatomae filtration, which results in loss of the yeast with the diatomae filter cake. Once a centrifuge has been placed in front of the diatomae filtration, the yeast suspended in the beer liquid can be recovered and sent back to fermentation house for reuse.	At present, waste yeast pulp from fermenter wash-out is collected for off-site reuse. Once a filter press is installed, the yeast pulp can be compressed in order to recover the beer liquid it contains.
Technical Details	Equipment is readily available and commonly used in breweries around the world.	Equipment is readily available and commonly used in breweries around the world.
Environmental Evaluation	40% COD reduction 20 tonnes (dry weight) yeast recovery	1.9% overall beer loss reduction
Economic Evaluation	Investment: 2.7 million yuan Pay-back period: 2.6 years	Investment: 2.6 million yuan Pay-back period: 3.0 years

is halted and the frying oil is replaced. The used frying oil is stored in a drum, and the oven is thoroughly cleaned with hot water and detergent. When the oven is completely clean, the oven is filled with new frying oil and the process is restarted.

The factors influencing waste and emission generation in the deep-frying process are shown in Figure 4.

Option generation

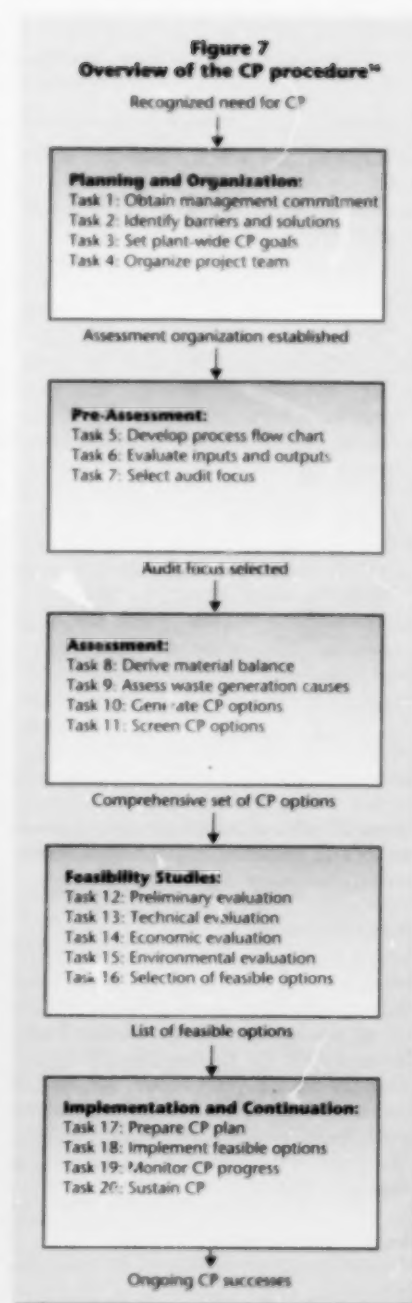
The next logical step is to develop alternate methods ("CP options") for eliminating or controlling the causes of waste generation. To this end, five general prevention techniques can be used. These are: product modification, input substitution, technology modification, good housekeeping, and on-site reuse and recycling. All five possible causes of waste generation can be dealt with using a particular prevention technique (see Figure 5). Information from the cause evaluation is used for the identification of the most appropriate CP approach, and information from the source identification for targeting to the source unit operation. Generating appropriate prevention options is still a creative step; the information obtained so far is used as a guiding tool in this creative process. The basic questions for the option generation are:

- 1) How should the product be modified to minimize or eliminate process waste generation?
- 2) Which input substitution is necessary to minimize or eliminate process waste generation?
- 3) How should the technology be modified to minimize or eliminate process waste generation?
- 4) How should the housekeeping be improved to minimize or eliminate process waste generation?
- 5) How could waste materials be recycled on site?

Brainstorming about these questions by the assessment team proves successful for generating options. In order to fully exploit the benefits of CP, it is essential to perform such assessments of unit operations frequently at various levels and departments within the company.

To illustrate option generation, the CP approaches have been applied to the **peanut deep-frying process**. The result is shown in Figure 6. The change to a dry-roasting process is an example of product modification, since it changes the product specifications considerably. The environmental burden caused by dry-roasting of peanuts has to be compared with the environmental burden caused by deep-frying them, in order to assess whether net environmental improvement occurs.

Changing the input materials could help reduce waste generation. A type of peanut would have to be found that is less subject to shattering. This would reduce product loss, as well as slowing down the decomposition process of the frying oil. Another opportunity is to switch to a type of frying oil which is less susceptible to decomposition. It would not have to be changed as often, which would help reduce waste (off-specification frying oil) and wastewater discharges (from equipment cleaning). Moreover, if



an environment-friendly oil were used, the waste oil produced would be less harmful to the environment.

Certain adjustments to plant equipment might be considered. As we have seen, broken peanuts left behind in the oven hasten the decomposition of the frying oil. If this residue were continuously filtered out of the deep-fryer, the decomposition of the frying oil would be slowed down. This would mean that the frying oil could be changed less frequently, thus reducing the amount of waste oil. According to the process description, the production processes in the peanut factory are highly automated. However, at the cleansing stage simple good housekeeping is an important factor.

The amount of water and the cleansing agent used could be reduced to a minimum, leading to a considerable reduction in waste generation. It may be possible to recycle the frying oil within the plant, if it can be reprocessed. It is not clear from the description whether this is feasible.

Next the options have to be evaluated, in order to figure out which combination of options generates the best economic and environmental benefits.

Organizing the CP efforts

The method described above should be embedded in an organized procedure. Following this procedure should be instrumental in organizing the CP efforts, informing the necessary stakeholders within the company and bringing together those persons who can develop, evaluate and implement the CP opportunities. The use of a four-step procedure, originally developed by the US EPA,⁶ is still widespread although a number of modifications have been incorporated in more recent publications.⁷ The original phases were: planning and organization, assessment, feasibility analysis, and implementation. With a view to minimizing the necessary efforts for CP, the use of a pre-assessment as a planning tool for the development of the CP activities has become widely accepted, especially for application in small and medium-sized enterprises in Europe.⁸ In Figure 7 the CP procedure has been elaborated into 20 tasks, which have to be conducted by the plant level project team. The procedure can be illustrated with a practical application in a brewery.

Beijing Brewery is a medium-sized enterprise under the Beijing First Light Industry Corporation. The production was 102,500 tonnes of beer in 1992, having a production value of 149 million yuan (US\$1 = 8.6 yuan). The brewery employs 1550 persons. Due to the extension of the production capacity in the course of 1991-1992, the existing anaerobic wastewater treatment plant became highly overloaded. This incited the management to participate in the Preparation Phase of the China Cleaner Production Project.⁹ In the course of 1993, a CP assessment has been executed by a plant-level assessment team with guidance from the Beijing Environmental Protection Bureau, the Chinese Research Academy for Environmental Sciences, and international experts from UNEP. The following results have been achieved in each phase of the assessment procedure.¹⁰

Planning and organization

Right from the start of the project, the management has been very positive about the cost-saving potential of CP for Beijing Brewery. The project team has done a good job in keeping the management informed about the progress of the CP assessment. In particular, the early CP results – through improvement of the operating practices in the bottling workshop – have fostered the ongoing involvement of management and contributed to the success of this CP project.

Next, the anticipated barriers have been classi-

Food Processing

fied as conceptual, institutional, technical and economic. To overcome these barriers, several CP information dissemination meetings have been organized in different departments of the brewery in order to raise awareness among the staff, workers and management of the entire company.

CP goals for COD reduction have been set at 20 per cent for the short term and 70 per cent for the long term. The short-term goal is based on the current overload of the wastewater treatment plant. The long-term goal is based on comparison of key production figures of the brewery with international figures.

The project team consists of six representatives from management and technical and environmental departments, and technicians from the production workshop. The limited size of the project team, as well as the enthusiasm of the team members, have made it a particularly successful one. Although the production manager did not formally participate in the project team, he was kept informed and actively involved in option generation and in the implementation of the good housekeeping options. The participation of the well respected technical director, as well as the enthusiastic manager of the environmental department, in the project team has created good factory-wide support for the CP project.

Pre-assessment

The pre-assessment at Beijing Brewery was mixed up with other parts of the assessment procedure. The preferred sequence for the pre-assessment is: development of a process flow chart, evaluation of inputs and outputs, and selection of the audit focus. Beijing Brewery worked the other way around, starting with the selection of the audit focus on the basis of a comparison of the key environmental figures between the two beer production units (see Table 1). Additionally, a process flow diagram was made in order to prepare for the assessment. Consequently, the pre-assessment is not comprehensive in terms of coverage of all input and output energy and material flows, and evaluation of the CP potential for all waste generating sources. However, the choice of the new brewery as the audit focus is evident since it is far more polluting than the old brewery.

Assessment

The assessment team devoted a lot of effort to the establishment of the materials balance. Analysis of the production statistics was combined with on-site observations of operating practices and working procedures, and on-site wastewater monitoring. The work on mass balances contributed to the understanding of the production processes and the waste generation sources, which in turn enabled the generation of 27 CP options in four categories: adjustment of product mix, control of the raw material inputs, optimization of the production processes, and recovery for on-site reuse. A first screening of the options took place on the basis of four criteria

Table 3
Overall results of short- and medium-term options at Beijing Brewery
(1000 yuan equals ±120 US\$¹⁷)

Beijing Brewery (at 120,000 tonnes annual beer production)						
Options Short- and mid-term options						
Item	Units (1000 yuan/ tonne)	Price (tonnes/year)	Rate Before CP (tonnes/year)	Rate After CP (tonnes/year)	Difference (tonnes/year)	Annual benefit (1000 yuan/yr.)
INPUTS						
<i>Raw materials</i>						
Malt	tonne	1.7	22,464	21,000	1,464	2488.8
Rice	tonne	1.8	8640	8640	0	
Diatomae earth	tonne	3	480	240	240	720
Glue	tonne	3.3	80.4	67.2	13.2	43.56
Lubricant	tonne	3.3	240	204	36	118
Fresh water	tonne	0.0003	1,800,000	1,200,000	600,000	180
OUTPUTS						
<i>Products</i>						
Beer	tonne	0.7	120,000	124,800	-4800	3360
<i>By-products</i>						
Distillers grain	tonne	0.0005	12,960	11,880	1080	-0.154
Used yeast	tonne	2.2	45	48	-3	6.6
Wastewater	m ³	0.006	1,440,000	900,000	540,000	324
<i>Solid waste</i>						
Diatomae cake	tonne	0.02	600	300	300	6
Total Benefits (1000 yuan/yr.)						7247.22

(expected technical feasibility, expected economic benefit, expected environmental benefit, and expected ease of implementation).

Feasibility studies

Beijing Brewery divided the feasibility analysis into a qualitative evaluation of the benefits of the implementation of the low- and non-cost CP options and a detailed (quantitative) feasibility evaluation for the expensive CP options. Thus far, two (equipment-based) options have been extensively evaluated for technical and economic feasibility and environmental desirability. The results of these feasibility studies are summarized in Table 2.

Implementation and continuation

An implementation schedule for all options has been made, with an indication of the departments in charge for the implementation. The options are divided in non- and low-cost options (ten options) and investment-requiring options (17 options). The non- and low-cost options include good housekeeping practices and strengthening of management, and were implemented in the course of 1993. The planning for implementation of the remaining options has been elaborated as follows:

Step 1: 30,000 yuan was invested in 1993 in the implementation of nine low-cost options;

Step 2: Set of technology-based options with high cost and high COD reduction potential. The total investment amounts to 5.96 million yuan, of which half had been commissioned by the end of 1993;

Step 3: Obviously beneficial options with poorly

accountable benefits (total investment 1.47 million yuan).

In 1994, progress has been achieved in the implementation of Step 2 (such as the installation of yeast centrifuges). In addition, Beijing Brewery started to monitor progress at the factory level. In order to sustain CP, progress has been linked to the bonus system for staff and operators. Additionally, it is anticipated that new CP assessments will begin targeting energy and water consumption in the brewery.

Learning to prevent waste generation

The role of "outsiders" in the development of a CP assessment is often neglected. However, most CP demonstration projects conclude that external guidance and supervision provided by either independent consultants/trainers (from consulting firms, technical assistance programmes, etc.) or internal consultants (for instance, from specialized staff of the corporate headquarters in multiple-plant companies) proved necessary in order to keep the assessment process going. The ultimate goal is to teach the company to prevent future waste generation. Key supervisory skills to this end are the ability to challenge the project team, the ability to critically review the assessment results, and the ability to add to creative thinking and problem solving.

As with other industrial innovations, several modes of supervision are possible. *Process-oriented* guidance and supervision, in which the supervisor contributes to the development of the problem-solving capabilities of the company, proves superior both in terms of results (implemented innovations) and in terms of learning to

innovate.¹¹ The *technical* approach (the supervisor supplies the company with the options and the company implements them) as well as the *programmatic* approach (the supervisor supervises the innovation – or assessment – process, while the company develops and implements the solutions) are less effective in terms of contributing to the development of ongoing (technical) improvements.

In CP auditing, the supervisor ideally combines the process-oriented approach with the programmatic approach. In the first role, the supervisor teaches the company how to identify and evaluate its waste problems and how to develop opportunities to prevent waste generation. In the second role, the supervisor creates the necessary conditions for the development of the assessment, for instance by planning meetings, writing reports and preparing (internal) presentations. In order to emphasize both aspects, it is often said that the supervisor of a CP assessment should be both a *trainer* and *consultant* to the company assessment team.

A review of the Dutch PROGRES project evaluated the role of the supervisors (consultants) in initiating the ongoing integration process of CP. It was suggested that the supervisor should strive for achievements in regard to four success factors.¹² These are:

1) *Achieving visible CP benefit*: for the environment as well as for the company's economic position. At Beijing Brewery it was rather easy to visualize the possible CP benefits; the beer losses

in the bottling department were an obvious economic and environmental problem, since as a matter of fact this beer was "not sold as product, but rather discharged as wastewater".

2) *Organizing a capable and motivated project team*, which should at least have the ability to understand how the facility operates, the authority and support to change the facility's operations, and the ability to maintain the CP spirit as old challenges are met and new opportunities arise. The project team at Beijing Brewery was extremely successful. It obtained its authority from the participation of the technical director in the team. In addition, the cooperation between the technical department, the environmental department and the production department fostered the smooth development and implementation of CP options.

3) *Generating new insights*, both in terms of waste generation causes and of CP opportunities. The CP assessment at Beijing Brewery made the brewery staff and management aware of the numerous non- and low-cost options for the improvement of operating practices and the strengthening of management. The most important new insight was therefore that CP goes much beyond the installation of advanced equipment.

4) *Introducing a preventive environmental management (or care) system*, for instance by linking CP with the Total Quality Management System. At Beijing Brewery, the results of the CP assessment incited the management to expand the

existing job responsibility system in order to include workers' care for water conservation and loss prevention into the regular job performance reviews.

The total benefits of the CP assessment at Beijing Brewery are summarized in a "before CP" and "after CP" comparison (see Table 3).

Example results

In order to illustrate the benefits of CP auditing in different sectors of the food processing industry, two examples from the Netherlands and China will be evaluated in more detail below.

Nestlé Amsterdam

Nestlé Amsterdam is a production plant which produces flavours (liquid or dry form), soups, sauces and bouillon.¹⁵ The company consists of three separate units: flavour plant, soup plant, and the packaging department. The main process in flavour production is the acidic hydrolysis of vegetable protein. The major waste streams generated at Nestlé are the flavour residue (solid waste residue from the flavour production), wastewater, and mixed solid waste. At Nestlé a CP project was undertaken with assistance from the University of Amsterdam.

After the pre-assessment, three priority areas were selected. These were: flavour residue, wastewater, and mixed solid waste. During the in-depth assessment of these priority areas, twelve viable prevention options were established. The implementation of four of them started within the 16 months of university-industry cooperation. For six options, feasibility studies were begun; for two of them, these were not yet carried out. The other options proved not to be feasible in the short term.

The most successful options for Nestlé were: enzymatic hydrolysis, decanting, on-site reuse of pump water, reprocessing of first rinse water from evaporators, substitution of evaporator cleansing agent, and off-site recycling of industrial waste components. Table 4 contains some details of these options.

The project team consisted of the director, the production manager, the manager of the packaging department and the process engineer (all from Nestlé), and two researchers from the University of Amsterdam. During the "planning and organization" stage the commitment and involvement of the plant management could be improved through the execution of the pre-assessment. This pre-assessment was rather labour-intensive for researchers, due to the complexity of the plant and its processes. In the "assessment" stage priority was given to the establishment of a coherent package of viable prevention options.

Due to the continuous fluctuations of raw material composition, it was not possible to draw up material balances. The translation of the general prevention techniques into practical prevention options by means of brainstorming by the project team was a great success. The selection of the most promising options was, however, rather complicated. Nestlé initiated the

Table 4
The most remarkable second year CP achievements at Nestlé Amsterdam²⁰

OPTION DESCRIPTION	IMPLEMENTATION	ENVIRONMENT	ECONOMICS
1. Enzymatic hydrolysis: use of enzymes for disclosure and (partial) hydrolysis of vegetable protein.	Laboratory experiments with promising results, especially regarding product taste.	About 50% reduction in use of adjunct materials (hydrochloric acid, soda and energy) and reduction of salt content of wastewater and residue.	Savings on adjunct material purchases, effluent charges and waste disposal costs.
2. Decanting: Replacement of cloth filtration unit for salt filtration by a decanter.	Implemented in 1991.	• Improved separation between salt and product, which results in improved product yield. • Reduction of rinse water usage.	Pay-back approximately 1 year.
3. On-site reuse of pump water: feed vacuum pump wastewater from soup plant into wet scrubbers of flavour plant.	Implemented in 1990.	Reduction of water intake by 118,000 m ³ /yr.	Pay-back within 2 months.
4. Reprocessing first rinse water from evaporators: reclaim flavour from first rinse water from evaporators.	Logistic consequences still have to be assessed in detail.	Reduction of water pollution with about 485 population units.	Reduction of effluent charges with Dfl 32,000/yr. and improved product yield.
5. Substitution of evaporator cleansing agent: substitution of cleansing agent for evaporator.	Implemented in 1991.	Reduction of water pollution with about 127 population units.	Dfl. 11,100/yr. savings on operational expenditures.
6. Off-site recycling of industrial waste components: segregated collection of paper, plastic and product spills for off-site recycling.	Segregated collection of cardboard and plastics started in 1990.	In total 98,000 kg/yr. industrial waste suited for off-site recycling.	Dfl. 29,500/yr. savings on waste transportation and disposal cost.

Food Processing

Table 5
Summary of the assessment results at Yantai Second Distillery²¹

OPTION	TECHNICAL CONTENT	ECONOMICS	ENVIRONMENTAL IMPACT
1. Good housekeeping in bottling department.	Repair of leaks and proper instruction of workers in order to avoid excess filling of the bottles.	Investment: 12,500 yuan Annual benefit: 523,000 yuan.	4.5 tonnes/yr. production increase.
2. Equipment repair and optimization in alcohol plant.	• Optimization of distillation reflux utilization. • Revamp of steam and condensate pipes. • Reuse of distillation tower condensate for fermenter disinfection. • Recovery of fermenter washout water.	Investment: implemented at no extra cost during yearly overhaul. Annual benefit: 5,040,000 yuan.	Potatoes input reduced from 3.81 to 3.09 tonnes/tonne alcohol. Production increase of 1200 tonnes/year.
3. Differential distillation.	Replace existing multi-tower distillation with differential distillation system.	Investment: 3,454,000 yuan. Pay-back period: 1.5 yr.	Steam conservation of 40%. Water conservation of 30%.
4. Continuous fermentation.	Replace batch-operated fermenters with continuous fermentation system in order to improve efficiency and eliminate wastewater from fermenter washout and disinfection.	Investment: 480,00 yuan. Pay-back period: 3.1 yr.	At least 1% production efficiency improvement. Elimination of 5000 tonnes/yr. wash water.
5. Boiler replacement	• Replacement of the boiler. • Continuous use of methane gas for power generation instead of co-firing.	Investment: 1,231,000 yuan. Pay-back period: 4.4 yr.	Coal conservation of 635 tonnes annually. Electricity conservation of 750,000 kWh/yr.

feasibility studies. In the meantime the researchers were involved in gathering knowledge from other sectors of industry that could be useful for Nestlé. The feasibility studies had not been completed at the end of the 16 months co-operation with the university researchers. The options which had been established as feasible were in the process of being implemented or had already been implemented.

Yantai Second Distillery

Yantai Second Distillery is a state-owned, medium-sized enterprise in the coastal city of Yantai, People's Republic of China. It is engaged in the production of grain liquors and red sweet potato wines. The plant employs 510 persons and has a production capacity of 5000 tonnes of alcohol per year. The production equipment dates from 1982-86. The single largest environmental problem in the distillery is the generation of 14 tonnes of distillers grain per tonne of alcohol. Since 1986, an anaerobic wastewater treatment facility is in operation in order to treat the 50,000 to 60,000 mg/litre of COD in the distillers grains. At present the methane gas is co-fired in the coal-fired boiler.

Although the distillery had already achieved much in preventing and treating pollution, environmental protection had not been linked with process control before. In order to identify CP opportunities, the distillery therefore participated in the Demonstration Phase of the China CP Project. A plant-level assessment team conducted a CP assessment for the distillery dur-

ing 1994 under the guidance of the Yantai Environmental Protection Bureau, the Ministry of Light Industry and the Chinese Research Academy of Environmental Sciences.¹⁴

During the pre-assessment it was found that the alcohol plant is the largest source of wastewater. In addition, several obvious good housekeeping options could be detected in the bottling department. The implementation of these options gave rise to an annual benefit of over 500,000 yuan at an investment of 12,500 yuan. This encouraged the team to proceed with the assessment of the alcohol plant. A number of low-cost technology optimization options had been identified which could be implemented at no extra cost during the annual overhaul period (summer 1994). This created another annual saving of just over 5 million yuan. In addition, three high-cost technology replacement options were identified and evaluated in detail in terms of their technical, economic and environmental aspects. The assessment results at Yantai Second Distillery are summarized in Table 5.

Concluding remarks

The examples of assessment results from selected food processing industries in China and the Netherlands illustrate the opportunities, benefits and constraints of CP. Application of a systematic working method has been crucial in achieving positive results in each of these companies; the CP assessment fostered the transformation of the generally-applicable CP "concept" into practical CP "options" tailored to the company-

specific circumstances (such as processes, materials, products, organisation, etc.).

A systematic working method for this CP assessment consists of three separate but interrelated components. Each of these components provides an answer to one of the basic questions in implementing CP at the factory level. The method provides an answer to the question of "how to generate alternate CP opportunities"; the procedure deals with the question of "how to organize the CP tasks within the company" and the guidance provides supervision on the issue of "how to prevent future waste generation". Each of these components might be implemented in different modes and with different intensities, which in turn creates a variety of working methods. Elsewhere, a division has been proposed between:¹⁵

1) *indicators*: industry-specific questionnaires that use process parameters and operating practices as evaluation tools for estimating the order of magnitude of the environmental as well as economic advantages of the outstanding CP options in a particular company;

2) *scan*: general checklists applied by a CP consultant to identify the most obvious CP options in a particular company, as well as the environmental "bottlenecks" in the production practices;

3) *pre-assessment*: plant-level audit tool based on overall process flow charts, inventories of input and output material flows, and a qualitative cause evaluation. The option generation is primarily based on the application of "example" CP options;

4) *assessment*: process-level audit tool based on material and energy balances and quantitative source and cause evaluation. Brainstorming among staff members, operators and technicians is an important option-generating tool, supported by the application of "example" options, benchmarking between companies, and technical reviews.

Each of these core working methods has its strengths and weaknesses. The time requirement for a company to undertake an assessment is remarkably higher than undertaking a pre-assessment or only a scan. The amount, as well as the type, of input from a supervisor are also different. So are the expected outcomes, which in case of an assessment might be an inventory of both the obvious and less obvious CP options as well as a contribution to the establishment of a preventive environmental management system and, in case of a scan, might be limited to just an inventory of obvious CP options. These differences call for a careful selection of the working method once a CP project in a particular company or industry sector is started.

Acknowledgement

The author's methodological research on CP assessment methods has been supported by the Foundation for Economic, Social and Environmental Research, which in turn is funded by the Netherlands Foundation for Scientific Research.

Notes

1. René (C.W.M.) van Berkel is Head of the Department of Product and Process Studies at IVAM Environmental Research, University of Amsterdam, P.O. Box 18180, 1001 ZB Amsterdam, the Netherlands. Tel. + 31 20 525 5080. Fax + 31 20 525 5850.
2. See, for instance: Freeman, H., et al., Industrial Pollution Prevention: A Critical Review, *Journal of the Air and Waste Management Association*, vol. 42, no. 5, pp. 618-656, 1992.
3. A detailed description of how to derive a material balance in practice can be found in: *Audit and Reduction Manual for Industrial Emissions and Wastes*, UNEP Industry and Environment Office/UNIDO, Technical Report Series No. 7, Paris, 1991.
4. Berkel, R. van (1994) *Comparative Evaluation of Cleaner Production Working Methods*, Paper presented at the First European Roundtable on Cleaner Production Programs, Graz, Austria, October 16-18, 1994.
5. First used in: Crul, et al. (1991), *Afvalpreventie: cursus voor ondernemers* (Waste prevention: training course for entrepreneurs), National Environmental Centre, Woerden, the Netherlands.
6. *Waste Minimization Opportunity Assessment Manual*, Hazardous Waste Engineering Research Laboratory, US Environmental Protection Agency, Cincinnati, 1988.
7. Such as, for instance, *Facility Pollution Prevention Planning Guide*, Pollution Prevention Research Branch, US Environmental Protection Agency, Cincinnati, 1992; *Minnesota Guide to Pollution Prevention Planning*, Minnesota Office of Technical Assistance, Minneapolis, 1991.
8. See for instance: Berkel, C.W.M. van and J.G.M. Kortman, Waste Prevention in Small and Medium Sized Enterprises, *Journal for Cleaner Production*, vol. 1, no. 1, 21-28, 1993.
9. The China Cleaner Production Project is designed and implemented under guidance from the UNEP Cleaner Production Programme and financed through a World Bank Technical Assistance Loan. A project description is included in: Wang Ji, et al., *Toward Cleaner Production in China*, in *Nature and Resources*, vol. 28, no. 4, 11-16, 1992.
10. *Cleaner Production Audit Report Beijing Brewery*, Beijing Brewery in co-operation with Beijing Environmental Protection Bureau and Chinese Research Academy for Environmental Sciences, Beijing, December 1993.
11. Buys, J. *Innovation and Intervention* (in Dutch: *Innovatie en interventie*), Kluwer Publishers, Deventer, 1987.
12. Ibid. 8.
13. Berkel, C.W.M. van, Prevention of Waste and Emissions at Nestlé Amsterdam, Report II, Part III in *PREPARE Manual and Experiences Document*, Ministry of Economic Affairs, The Hague, the Netherlands, 1991.
14. *Cleaner Production Audit Report Yantai Second Distillery*, Yantai Second Distillery in co-operation with Yantai Environmental Protection Bureau, Ministry of Light Industry and Chinese Research Academy for Environmental Sciences, Yantai, December 1994.
15. Ibid. 3.
16. Berkel, R. van, R. Boesten, D. Huisingh and L. Baas, *Cleaner Production Training for Cleaner Production Promoters of the UNEP/UNIDO National Cleaner Production Centres*, IVAM Environmental Research, Amsterdam, October 1994.
17. Ibid. 10.
18. Ibid. 10.
19. Ibid. 10.
20. Table derived from: Berkel, R. van, Examples of Successful Transitions Towards Industrial Waste Prevention Effected by Industry-University Co-operation, in Mikkanen, R. and S. Pöyry, *Conference Proceedings ENTREE: A Development Conference on Environmental Training in Engineering Education*, October 21-25, Laxenburg, Austria, 1991.
21. Ibid. 14.

Cleaner production activities at the Environmental Management Institute in Beijing

Ning Duan, Director, Chinese Research Academy of Environmental Sciences, Beiyuan, Anwai, Beijing 100012, People's Republic of China

Located in Beijing, the Chinese Research Academy of Environmental Sciences is the single largest research and consulting organization in the environmental field in China. The Environmental Management Institute (EMI) of the Academy works on issues of policy, economic analysis, planning, computer software, managerial theories and their applications, and so on in relation to the environment.

One of the major activities EMI has been undertaking in the last two years is the project on "Improving Cleaner Production (CP) in China". Financially the project is supported by the World Bank. Technically and theoretically it is guided by UNEP Industry and Environment.

Together with experts from UNEP IE, EMI conducted 29 CP audits in 27 companies in the World Bank project. In the 27 companies located in 13 industrial sectors, 690 CP options have been identified. Among them, options of product updating account for 2.5 per cent, raw material substitution 6.2 per cent, technology renovation 35.4 per cent, good housekeeping 39.4 per cent, on-site

recycling 14.6 per cent, and others 1.9 per cent.

Among the 620 options whose costs can be relatively precisely calculated, non- and low-cost options account for 66.3 per cent, medium-cost options 14.8 per cent, and high-cost options 18.9 per cent. 60 per cent of the 690 CP options have been implemented, including a few medium- and high-cost options. Actual statistics from the 29 audits show a reduction of 30 to 50 per cent of pollutants at the point where the audit was focused. Some companies changed their previous pollution control plans, which were end-of-pipe oriented and demanded huge amounts of capital investment and O/M costs.

Very encouragingly, EMI has been selected by the UNIDO/UNEP joint NCPC programme as a basis for the China National Cleaner Production Centre. The Centre currently considers six fields as its working focus: policy recommendations, information exchange, training and publicity, CP auditing services, establishment of demonstration projects, and dissemination of CP concepts and technologies.

Food Processing

Environmental adequation of a sugar and alcohol mill in Brazil

Guilherme de Faria Barreto, Humberto E.S. de Mello, and Bruno Garzon, Environmental Consultants.
Rua Levindo Lopes, 191, Savassi, 30.140-170 Belo Horizonte, Minas Gerais, Brazil

Abstract

A cleaner production assessment aims at the identification, evaluation and implementation of CP opportunities in a company. A systematic working method, which facilitates the execution of a CP assessment, generally consists of three separate, interrelated options: method; procedure; and guidance and supervision. In addition to introducing these elements and their applications in the food processing industry, this article presents plant-level assessment results to illustrate the possible benefits of CP in various food processing sectors.

Résumé

Pour répondre aux contraintes résultant des nouvelles réglementations en matière de protection de l'environnement (telles que les mesures concernant l'impact des déchets liquides), le Jatiboca Mill a lancé un programme visant à résoudre les problèmes écologiques liés à la production de sucre et d'alcool combustible à partir de la canne à sucre. Les projets en cours vont du recyclage des résidus industriels à l'éducation en matière d'environnement. Au chapitre des résultats déjà obtenus : un changement d'attitude à différents niveaux de l'entreprise et une amélioration de son image aussi bien interne qu'externe.

Resumen

Enfrentado con la necesidad de cumplir con los nuevos requisitos de protección medioambiental (por ejemplo, los relativos al impacto de los líquidos residuales), el molino Jatiboca Mill ha iniciado un programa dirigido a tratar los temas medioambientales relacionados con la producción de azúcar y alcohol combustible a partir de la caña de azúcar. Los proyectos que se están poniendo en marcha van desde el reciclado de materiales de desecho de procesos hasta la educación medioambiental. Entre los resultados ya alcanzados están un cambio de actitud en distintos niveles de la empresa y una mejora de la imagen interna y externa de ésta.

Introduction

Cane sugar production is one of the oldest industrial activities in Brazil. Over the past centuries, the method of production of this "food-stuff" has undergone continuous changes. In the early 1970s, as a result of the oil crisis, Brazil designed and implemented a large-scale programme for the production of fuel alcohol from sugarcane for automotive purposes. Thus, in addition to sugar, many of the country's oldest refineries also began producing fuel alcohol, which over the last two decades has become an excellent substitute for gasoline. However, the fuel alcohol production process produces abundant amounts of a liquid waste called *vinhaça* or *vinho*. To address this new impact on the environment, existing regulations were reformulated by the Brazilian environmental agencies. Hence the need felt by the Jatiboca Mill to adjust to the country's new environmental requirements.

Established 74 years ago, the Jatiboca Mill is located in a rural, tropical Atlantic area (the District of Urucania in the State of Minas). From the Mill's landholdings – a total of 13,500 ha consisting mainly of sugarcane fields, in addition to orchards, forest reserves, pastures, and rural settlement areas – 800,000 tonnes of sugar

cane are harvested each year. From this, 1.2 million 50-kg sacks of crystallized sugar and 15 million litres of anhydrous alcohol per year are produced for use by alcohol-run vehicles.

The soils used by the Jatiboca Mill for sugarcane-growing were formed in the Early Precambrian period by the weathering of acid rocks of the gneiss and granite types. Most of them have a good fertility level and are classified as orthodystrophic reddish-yellow latosols (LV2), normally acid, or reddish-yellow orthoeutrophic podzols (PE5). Dark alluvial soils of greater fertility also occur in the flat, low land along watercourses.

The region's climate is Cwa (Köppen's classification), which means a mesothermal climate characterized by hot, rainy summers (wet subtropical climate). Annual rainfall is around 1200 mm. The dry season lasts approximately three months and coincides with the coldest months of the year (June, July and August). The mean annual temperature is 21°C.

Development

The production of crystallized sugar and fuel alcohol for automotive purposes involves several polluting processes. However, the impact of

these processes is almost totally mitigated by the Jatiboca Mill (see Figure 1).

The waste products originated by the sugar and alcohol industry are as follows:

Sugarcane bagasse

The Jatiboca Mill produces 800 tonnes of bagasse daily, of which around 92 per cent is consumed as boiler fuel. The remaining portion is stored until the next crop, to allow restarting of the mill's operations.

Filter cake

This is the material obtained after vacuum filtration of the sludge from the settlers, in the proportion of 40 kg per tonne of ground cane. All of it is applied as a soil fertilizer during the reforming of the mill's sugarcane fields.

Boiler ashes

These result from the burning of sugarcane bagasse in the boiler furnaces. As with filter cake, the boiler ashes are also used for soil fertilization due to their high potassium content.

Atmospheric emissions

The atmospheric emissions produced by the Jatiboca Mill are mostly soot, smoke and air from the burning of sugarcane bagasse in the boilers. Measures to mitigate their impact have yet to be implemented.

Liquid effluents

The main liquid waste from fuel alcohol production is *vinhaça*, the residue left after distillation of the fermented wine or must. As many as 12 litres of *vinhaça* are obtained for each litre of alcohol produced.

In the beginning, sugar and alcohol producers simply discharged this liquid waste into the nearest watercourses. However, because of its high organic matter content (which makes it a strong pollutant) *vinhaça* became the object of extensive research work. As a result, it is known today that when applied at the rate of 250 m³/ha/year, *vinhaça* can be extremely beneficial to sugarcane growth as it is quite rich in potassium, a nutrient whose absence or insufficiency in the soil can be the most restricting factor in the development of this plant.

Chemical analysis of the *vinhaça* produced at the Jatiboca Mill shows the following composition: N = 0.26; P₂O₅ = 0.10; K₂O = 1.44; Ca = 0.45; Mg = 0.15, in addition to a large percent-

Food Processing

tage of water, which makes it an excellent option for sugarcane irrigation (see **Figure 2**).

Similarly to *vinhaça*, other liquid effluents (floor and equipment washwater, condensed waters, etc.) from the sugar and alcohol production process are used in "fertirrigation". This has permitted total replacement of the commercial fertilizers that used to be applied on recently harvested fields, and partial replacement at new fields. In addition to helping preserve the environment, a considerable reduction in sugarcane production costs has been achieved.

A major consideration in developing the "fertirrigation" methods to be used was the need to prevent the contamination of springs and watercourses, while ensuring optimum application rates.

To allow the application of *vinhaça* and other liquid wastes, an array of specially designed infrastructure facilities and equipment have been made available. These include sedimentation tanks, settling and storage ponds, irrigation canals, fiberglass-reinforced piping, stainless steel pumps and motors, sprayer assemblies coupled with motor pumps, and sprinkler trucks.

In addition to the above services, which are supervised daily by the mill's technicians, a number of others have been performed over the past two years by specialized environmental consultants hired by the Jatiboca Mill. Among them are projects for the preservation of the existing animal and plant species in the Company's forest reserves; environmental education of the mill's employees and their families; administration of lectures and courses on environmental conservation; afforestation of riverhead and riverside areas; arboriculture and landscaping projects; and technical assistance to the mill's forestall nursery.

Biotic environment characterization and plant life monitoring

In order to assess the impact of the activities of the Jatiboca Mill on the environment, it was first necessary to determine the current conditions of the native vegetation and the animal life sustained by it. A characterization of the biotic environment was carried out, followed by monitoring of the local plant life. In addition to the sugarcane plantations, which cover most of the Company's lands, pastures, orchards, crop fields (cassava, corn, eucalyptus, guava) and remnants of the Atlantic Forest were also inventoried. The latter, of special interest to conservationists, cover mainly the tops of hills and have been protected for the past 50 years. In general they are well preserved, with very large trees, some of which can reach a height of 40 metres, particularly in small areas of older vegetation.

As concerns animal life, the survey included groups of amphibians, rep-



View of the Jatiboca Mill facilities

tiles, mammals and birds, with special attention to the latter as they are excellent indicators of environmental health. Even though a strong influence of artificial environments could be detected in all groups, species that are typical of well preserved environments and even some rare,

threatened species were found, particularly in the areas covered with denser, farther-spreading vegetation.

Forestall Nursery

To provide the seedlings needed for the reforestation of riverhead and riverside areas, as well as for arborization and landscaping of the mill yard and residential villages, a nursery with a production capacity of 15,000 seedlings/year has been established by the Company. Selection of the plant species to be cultivated and the management methods are defined jointly by the Company's technicians and the environmental consultants. Preference is given to fruit trees and native Atlantic forest and savanna species.

Arborization and landscaping

To attenuate the negative visual impact created by the industrial unit, a number of landscaping projects have been started by the environmental consultants. These include the building of gardens and fences, the painting of buildings and offices, and the planting of fruit essence trees of varied flowerage. The projects were commenced in 1993 and should be completed by 1995.

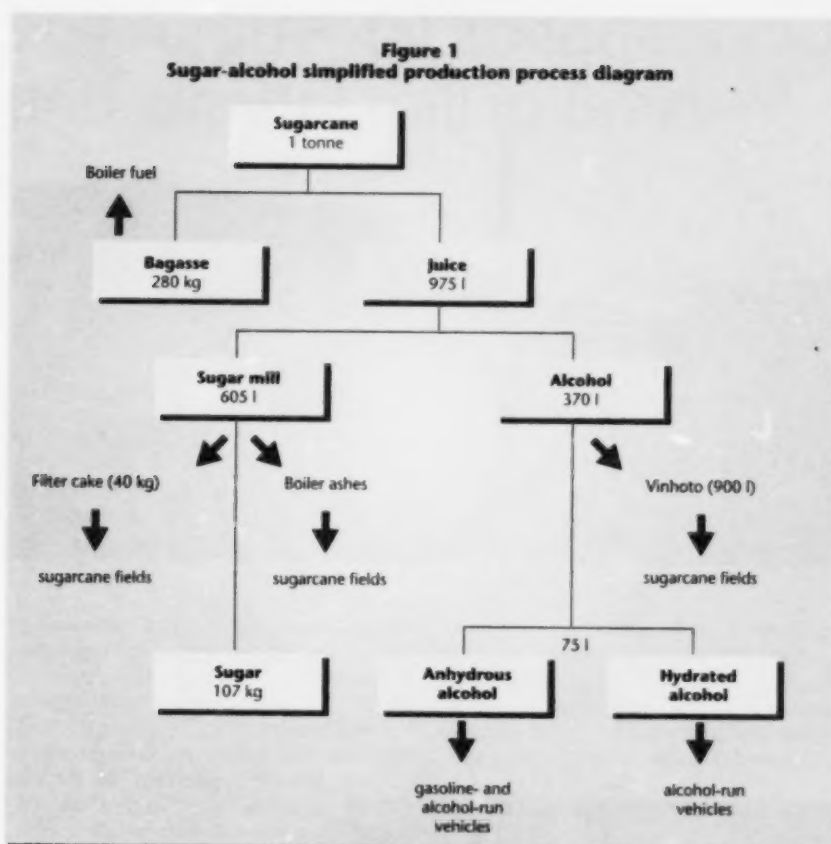
Forestation of riverhead and riverside lands

In view of the degraded conditions of the rivers that cross the Company's lands, a project was initiated in 1992 by the Jatiboca Mill, aiming primarily at renewing the forest cover in riverhead areas and along the banks of these rivers, so that they can benefit from the hydraulic-forestall function of such vegetation.



A giant chicha tree (*Sterculia chicha*), one of the many rainforest species preserved in the company's reserves

Food Processing



The project involves the random planting of pioneer species and essences that are native to the region, with appropriate techniques including adequate spacing, irrigation, etc. being applied to ensure the successful development of the trees. It can be estimated that these areas will be totally regenerated within approximately 20 years.

Environmental education programme

Since 1992, a comprehensive environmental education programme has been systematically

implemented by the Company's environmental consultants for all members of the local community, whether or not directly involved with the sugar and alcohol production activities.

For the children of the Company's employees, for instance, the programme includes environment-oriented school activities in addition to guided visits to the mill and to its forest reserves, some of which are considered remnants of ancient forests. As a result of these efforts, changes in the children's attitudes and behaviour

can already be observed.

The teachers working at schools within the Company's area of influence are also given special attention by the environmental education specialists, as they are the main multipliers of conservationist methods and practices. Courses and lectures are provided to them regularly on subjects such as pollution and health, garbage recycling, etc.

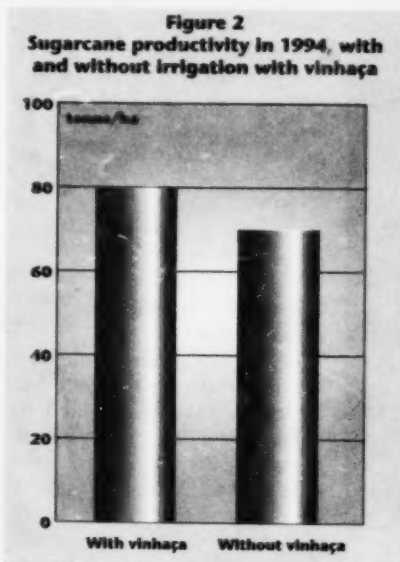
Approximately 220 primary school students, 20 teachers and 800 Company employees have benefitted from this programme.

The political community and non-governmental organizations are also often invited to visit the mill so that they can get acquainted with the sugar and alcohol manufacturing process, as well as with the environmental protection and adequation projects being developed by the Jatiboca Mill.

Conclusion

The implementation of an environmental management programme at a company that has been in existence for over 50 years requires patience and persistence, as working on the environment calls for investments and the return, whether environmental or financial, can only be realized after a few years. Thus the results obtained are still partial, since the period of maturation of projects of this type is much longer than the two years of work carried out until now. However, there are clear indications that a positive change has occurred, from an attitude of unawareness of environmental issues to a new culture that values the rational use and efficient management of renewable resources, adequate organization and planning of the work environment, and improvement of the physical aspect of the industrial unit and workers' villages.

Finally, at least two important results have already been achieved: a change in attitude towards environmental processes at the various levels of the Company, and improvement of the Jatiboca Mill's internal and external image. ♦



The children of the Company's employees take part in environmental education activities

More food, less waste in seafood processing

Erik Andersen and Claus Jespersen, Matcon, Geneator vej 45, 2730 Herlev, Denmark

Abstract

Matcon is a consulting company with worldwide experience in seafood processing and clean production. This article describes some of the clean production options available in the seafood industry, which is facing demands to establish environmental protection measures. Companies must consider major investments in pollution control at a time when many of them are struggling to survive financially. Emphasis is therefore given to economically feasible solutions. The examples illustrate improvements in single processes and in overall production.

Résumé

La société de conseil Matcon jouit d'une expérience internationale dans le traitement et la production propre des fruits de mer. Cet article présente quelques-unes des technologies propres pouvant intervenir dans la production de fruits de mer – un secteur qui fait l'objet d'exigences croissantes en matière de protection de l'environnement. Désormais, les sociétés doivent consacrer des sommes importantes au contrôle de la pollution alors que nombre d'entre elles luttent déjà pour leur survie. Cet article privilégie en conséquence des solutions économiquement viables. Les exemples cités montrent des améliorations portant sur des processus déterminés et sur la production globale.

Resumen

Matcon es una empresa de asesoría con experiencia por todo el mundo en el procesamiento de marisco y producción limpia. En este artículo se describen algunas de las opciones de producción limpia disponibles para la industria marisquera, que se encuentra bajo presión para establecer medidas de protección medioambiental. Para ello, las empresas deben emprender importantes inversiones para el control de la contaminación en un momento en el que muchas de ellas están luchando por sobrevivir financieramente; por tanto, se subrayan las soluciones viables desde el punto de vista económico. Algunos ejemplos ilustran las mejoras en procesos individuales y en el proceso total.

According to the definition, *cleaner production* in production processes means conserving raw material and energy and reducing waste. Or, as indicated in the title, getting more food and less waste from the same amount of raw material.

It is important to realize that even if the technologies are available, clean production will only be introduced if it brings an economic benefit. This can be achieved in the seafood industry by obtaining higher yield from the same raw material and utilizing waste for secondary products. Further use of resources can be minimized and discharge reduced, which may further improve economic results.

Cleaner production is achieved by applying know-how, by improving technology, and/or by changing attitudes. This article is about implementing cleaner production in the seafood industry, illustrated by practical examples from Matcon's extensive work in this field.

Environmental demands on the seafood industry

Until recently, the seafood industry did not have to meet major environmental demands. As a result, it is causing considerable pollution of the

environment. The industry is now facing growing demands from local and central authorities to establish fast and efficient environmental protection. These demands have forced the companies to consider and plan major investments in pollution control. And this in a period when many of them are fighting simply to survive financially.

The resources used in the seafood industry can be described as mainly raw material, water and energy. The discharge consists of offal and process water contaminated by protein and oil.

In principle, there are two ways of reducing the pollution:

- 1) building public or company-owned wastewater treatment facilities to clean the actual effluent of the industry;
- 2) reducing the amount and degree of pollution of the effluent as much as possible before construction of new wastewater treatment facilities.

Solution No. 1 is the traditional way of trying to solve the problem and will typically involve heavy investments in large-scale treatment plants, which may later prove to be over-sized and not feasible from a socio-economic point of view. In contrast, No. 2 can offer considerable

economic advantages, from an investment as well as an operational point of view.

The clean/low waste technology concept

Any type of production, including fish processing, can be illustrated as shown in Figure 1. By introducing clean production, the process is changed and the following achieved:

- ◆ Better exploitation of the raw material leads to increased amounts of finished products (without increasing the amount of raw material);
- ◆ The part of the raw material which cannot be made into primary finished products can be used advantageously in producing other types of saleable products. Such secondary production can take place in the factory or elsewhere.
- ◆ The consumption of energy, water and secondary materials is reduced.

After introduction of clean production, the above production can be illustrated as shown in Figure 2.

The effect: improved environment and improved economic result

Typical examples of clean/low waste technology components for seafood industries are:

- ◆ motivation, training and management;
- ◆ improved exploitation of the raw material via introduction of modern production control systems;
- ◆ water-saving activities and equipment;
- ◆ improvements of existing machinery and installations;
- ◆ "dry" and decentralized collection of offal;
- ◆ microfiltration of wastewater.

In the following, some of the options for introducing clean production in the seafood industry will be described and illustrated by Matcon's experience.

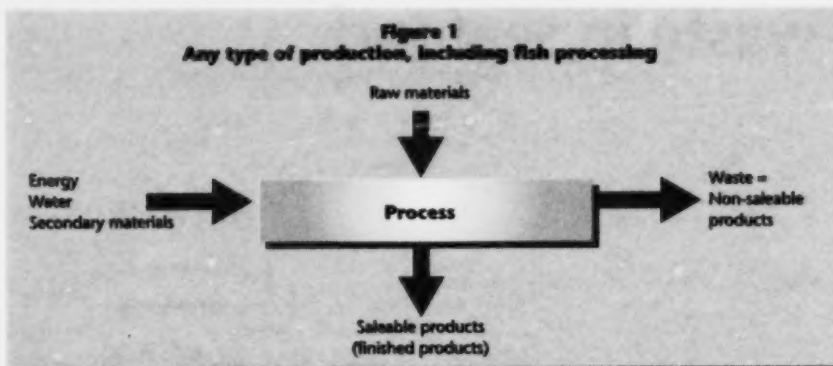
Motivation, training and management

The introduction of clean production requires knowledge of where resource use takes place and where raw material is lost. As indicated in the introduction, as a side-effect of reducing waste it is very often possible to:

- ◆ increase the amount of finished product from the same raw material;
- ◆ improve product quality.

To gain these benefits, knowledge, good management, motivated employees, and suitable technology are required. Besides less polluting

Food Processing



production, an economic advantage can often be obtained.

Experience with several kinds of seafood processing shows that the environmental load from production depends, among other things, on the quality of the raw material. The difference between high and low quality can be 10-16 kg COD per tonne of raw material. This makes quality an important issue in clean production.

Matcon's experience is that, in developing industries, the best way to start is most often the workshop approach, either for one company alone or for a group of industries within the same field. The workshop can reach a large audience. Changing between theory and practical examples from the participants' daily work secures an understanding of the fundamentals of clean production and provides important motivation. The workshop covers issues like: quality criteria in the market, management, economics and technology. The participants should be management and representatives of the employees involved in production. The workshop typically includes:

- 1) a two-day course covering management, technology, economics and the market;
- 2) two to three days for plant evaluation and elaboration of an introduction to the following discussion. The chosen plant provides practical examples in the discussion, which covers the topics of management, layouts, technology and quality assurance;
- 3) discussion, with management and employees together, on how the plant should improve, and elaboration of a working programme.

Understanding the interlinked connection between clean production, and the company's

processing policy and management, is necessary in order to start thinking about clean production. Our experience is that it is also possible to give directions on changes that lead to cleaner and more profitable production.

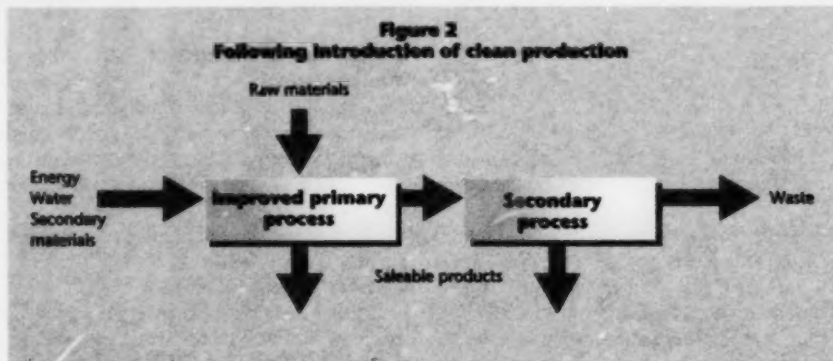
The evaluation of the plant points out where product is lost and quality lowered. The environmental and economic consequences are discussed in the third part of the workshop, serving as motivation and forming the basis for future development of the plant.

Actual improvement will depend on the stage of the industry. Most often the improvement process, once started, is continued by the seafood industry itself or through further assistance from the consultants.

Example from the whitefish industry - hake processing

Matcon has worked intensively in hake processing in South America, Namibia and South Africa. Hake can be a delicate fish to process. If not handled carefully starting from catch and continuing during production, it will deteriorate rapidly, the main problems being bruises and the texture's turning soft. The fish tend to get stuck in the machines. They are easily torn apart in machines and during manual trimming. Previously the yield was unknown, as were the places and processes where there were losses during production. Lost product falls to the floor and is washed out during cleaning.

Through the introduction of production control systems, proper training and production adjustment, it is possible to obtain improvements such as those shown in Table 1.



Water-saving activities

The use of large amounts of water characterizes the seafood industry. Water is a valuable resource that should be spared. Excessive use of water will also increase the amount of matter being washed out. Knowledge of the equipment and evaluation of water use can lead to great reductions.

On machines, water intake should be adjustable to species and quality. Nozzles can often be reduced or even removed. Continuously running water should be avoided. The introduction of solenoid valves that stop water use when no product is present is a useful solution.

Experience shows that, without the introduction of clean technology, manual processing uses as much water as, if not more than, machine processing. The introduction of spray guns in manual processing avoids running water. Increasing the operator's attention to water use also helps reduce its consumption.

After introducing clean technology, we find a reduction in water consumption for a filleting line of 65 to 75 per cent. The pay-back time is dependent on the price of water, but is usually very short.

Water can in many cases be recirculated and reused. Recirculation of water always needs to be carefully evaluated, as hygiene precautions may need to be taken. Often water from a "clean" process can be reused in a less hygiene-demanding process, or for cleaning. Examples are: recirculation systems for thawing seafood; and reuse of water from filleting/peeling machines for thawing, transport or washing purposes.

The shrimp processing industry uses large quantities of water, especially in peeling machines. Several systems for recirculating water exist; but as peeling takes place after the shrimps have been boiled, the peeling process takes place in a bacteriological "high risk" area. This requires the plant to carry out routine control of hygiene. The solution designed by Matcon reduces the risk of contamination, and bacteriological examinations showed no difference compared with normal processing. Reduction in water consumption is as much as 65 to 80 per cent for a 10 m³ per hour peeling machine using Matcon's design.

Cleaning is responsible for a large part of water consumption. A specially developed system for reusing, filtering and storing water for cleaning has reduced water consumption for cleaning by 50 per cent and is being used in several kinds of seafood industries.

New equipment solutions

The options will depend on how developed the industry is. The more developed the industry, the more sophisticated the technology that must be introduced.

An example of the introduction of more sophisticated technology, and of what a thorough review of an existing type of production may provide when evaluated from the point of view of clean production, is the introduction of a robot in the production of pickled herring - the

Food Processing



Senior Consultant Andreas Villadsen checks the dry collected waste from the filleting process. Water consumption has been reduced by more than 60 per cent and discharge by 75 per cent. A positive side effect of reducing the use of water in production has been an improved working environment

staple of the Scandinavian lunchtime menu. In the traditional process, the herring fillets are immersed in brine for a day, then in a vinegar marinade, and are stored for a longer period in a barrel before being mixed with special sauces or marinade and shipped for sale.

Review of the process, and experiments, resulted in a new procedure using less (and more concentrated) brine. The step with vinegar in the container was eliminated. Marinating now took place directly in drums, reusing the brine from the first step.

A vital part of the process is to make sure the fillets are thoroughly stirred. The improved stirring process results in a better flesh consistency. Moreover, the new process is more careful and consequently the fillets are full-edged. This gentle process reduces the loss of meat from the fillets, so that the yield increases by 1.5 to 2 per cent measured in relation to the raw material, or 3 to 4 per cent in relation to the finished product. The new process produces a more uniform product with higher quality, as the robot causes less damage to the fillets.

At the filleting plant, the new process has reduced water consumption by 54 per cent, discharge of brine by 92 per cent, and the level of pollution by 93 per cent (see Table 1). Discharge increases in retail packing, but the total is still a reduction in water consumption and discharge of 55 per cent, and in pollution of about one-third.

The robot has been successfully used for other

marinating purposes where gentle stirring is preferred, also giving higher yield and better quality.

Waste treatment

An important issue in reducing waste is waste treatment in the plant. The general approach is to:

- optimize production;

Table 1
Improvements resulting from the introduction of clean production in hake processing

Flesh recovery:	Yield of finished product from headed and gutted fish, from 48 up to 56%. Improvements were equal to approximately 10% more final product.
Quality potential:	Before: 60% could be used for first class product. After: Up to 90% could be used for first class product.
Contribution margin:	Doubling of the contribution margin is definitely realistic, and it may in some instances be even higher.
Workforce:	Unchanged, or there is a possibility of increased employment through manufacturing of more valuable products.
Environment:	Significant improvements, due to reductions in water consumption and discharge. Before, one could actually see flesh pieces from torn fish/fillets being washed to the drain.

- collect waste at the source;
- separate waste from water;
- avoid pumping/mechanical treatment of waste in water;
- extend knowledge of the importance of clean production to all levels of production;
- measure the resources being used at each processing step.

It is important to realize that raw material waste is a non-saleable product. Therefore waste is not only a source of pollution, it also means loss of product. Loss of product occurs for a variety of reasons: improper handling, poor management, insufficient equipment, careless attitude, etc. It all adds up.

The quality of the raw material is also important. The more spoiled the raw material, the more pollution. Not only is a greater amount dissolved from the seafood, it is also more difficult to handle it, resulting in more waste.

Separating waste from water at the source is the best solution. Longer contact with water results in more waste being dissolved and suspended in the water. Much of the waste consists of guts and blood, which are easily dissolved and have a very high oxygen demand when discharged. Mechanical treatment of waste in water also means that more waste is dissolved, and that a water/oil emulsion may be formed, which could cause a problem in a waste treatment plant.

Dry collection of waste through the introduction of a filterband conveyor under the filleting machines, thus avoiding pumping, and the introduction of a filterband for wastewater cleaning can reduce the discharge of effluent significantly.

Direct and dry collection of waste increases the amount of waste by approximately 2.5 per cent. Offal collected this way has also shown to be more valuable than normal waste due to the lower water content. This lower water content means subsequent facilities, often fish meal plants, use less energy in production and get less waste, adding to the positive environmental effects and economic results. Further, less energy is used for transportation.

Implementing clean production in a herring filleting plant

An example of the effects of implementing clean production is the project in the Szkuner filleting plant in Poland, which is supported by the Danish Environmental Protection Agency. The plant processes approximately 10,000 tonnes of herring annually.

The project at Szkuner has changed the pattern of preliminary herring processing, including nobbing and filleting, by introducing the following clean technology components:

- modern production control systems;
- changes in and optimization of production equipment;
- dry collection of offal to replace the present system of water transport;
- avoiding pumping, changing the flow of wastewater to a "soft flow";
- a filterband for wastewater cleaning;
- utilization of offal.

Food Processing



Computer-controlled flowlines can ensure shortened processing time and optimal use of the raw material. Irwin and Johnson in Cape Town is among the leaders in utilization of hake.

Table 3 shows the environmental load before introducing clean production and the results realized after implementation. The plant also gained an economic benefits from:

- ◆ higher income due to increased amounts of saleable products and saleable offal;
- ◆ reduced water consumption and costs;
- ◆ reduced investments in waste and wastewater treatment, which can be scaled down as a result of the clean/low waste technology;
- ◆ reduced operating costs for wastewater treatment.

Before, the offal was used for fish meal production, which had a very high content of effluent in the wastewater. The offal is now being used for silage production at the plant, without any wastewater except a small amount for cleaning purposes. Further, the plant earns more money on the silage.

Overall, the amount of wastewater has been reduced by an amount that equals wastewater from 50,000 persons. A similar reduction obtained through a traditional wastewater treatment plant would cost ten times as much.

The investments required to introduce clean production in a middle-sized Polish plant like this one are estimated to be in the range of US\$ 300,000-500,000. Based on the above experience, the pay-back period will be only two to three years.

Aquaculture

Fish and shrimp farming offers interesting possibilities for food production, including farming

Table 2
Discharge from the brine of salted and soured herring fillets at the filleting plant/department

	Before	After	Reduction
Water consumption m ³ /t RF	1.49	0.69	54%
Water discharge m ³ /t RF	1.13	0.09	92%
COD kg/t RF	27.78	1.85	93%

(1 RF = tonnes of raw fillet)

of valuable species to gain a good profit. The production of farmed fish and shrimp has increased sharply for the following reasons.

There are several environmental problems related to farming. In dry periods aquaculture may compete for water needed in the surrounding area, including for agriculture. Aquaculture also discharges substantial amounts of organic matter. Most of the organic discharge is suspended or soluble, and the total discharge to the aquatic environment of nitrogen, phosphorous and BOD is of such quantities that the capacity of the recipient is exceeded in some cases.

The discharge arises from the leaking of feed into the water, and from fish/shrimp excretions. It may reach such a level that it stresses the fish, making them more susceptible to diseases. This may lead to another problem, which is the use of antibiotics and other drugs in aquaculture. Their extensive use has an inheritant risk of creating resistant pathogenic bacteria.

Optimizing the feed can lower the environ-

mental load from aquaculture significantly. In trout farming this has been achieved through an optimized composition of amino acids, giving a higher digestibility and, more important, increasing the oil content of the feed, thus reducing the protein content. This means that less protein is used for energy, and the same amount of fish can be produced with a reduced amount of feed. Consequently, the discharge of nitrogen, phosphorous and BOD has been reduced by more than 50 per cent.

Intensive shrimp farming is more recent than trout farming, and no doubt much can be gained by optimizing the feed for shrimps. (Some ship farms have been placed in mangrove areas, which has proved an unnecessary attack on nature.)

Another important clean production approach in aquaculture is the introduction of recirculated systems. The water is partially cleaned and reused. Ammonia, arising from protein in the feed, is toxic to the fish/shrimp and must be removed. Thus it is converted to nitrate, but nitrate also affects the fish. In normal recirculated systems 3-5 per cent of the total basin volume must be exchanged per day, resulting in consumption of 200-300 litres of water per kg of feed. The experience from the first recirculated systems was not very impressive, with lower growth rates than in common aquaculture, but knowledge and the systems have improved since.

The best available technology in the field is that of fully recirculated systems, very few of which exist. The system designed by Matcon reduces water exchange to 1-2 litres per kg of feed. This is close to just replacing the evaporated water. During the six-month test period no drugs were used. The first system has now been running for almost two years, and growth rates are better than in normal systems. The sludge is also considerably less, compared with normal recirculated systems.

Conclusion

The knowledge and technology for large improvements and clean production in the seafood industry are available today. The next important step is to make sure this information reaches the industry and authorities. In our experience, it is mainly the best industries that use consultants to improve their production. This may seem a paradox at first glance, but these companies have more knowledge of what it takes to improve and what can be expected. The common approach known to us is to support development and implementation of clean production in one plant serving as a model for others.

In Denmark, an interesting new approach to spreading the knowledge of clean production processes is the gathering of all relevant information on clean production in the seafood industry in a database. The database, which can be purchased for a fairly low price, contains descriptions of the production and processes for all important species in Denmark, together with information on resource consumption, waste, discharge, environmental aspects, and best available technology. ◆

Table 3
Water consumption and environmental load from a herring plant filleting 10 tonnes per hour. The values are maximum values, and the figures for COD and BOD are before any wastewater treatment

	Water consumption	COD		BOD	
	m ³ /h	mg/l	kg/h	mg/l	kg/h
Before clean production	15	9400	330	3800	130
After clean production	15	3136	47	2083	31
Reduction	50%	67%	86%	45%	76%

Cleaner production at the Fuyang General Distillery in the People's Republic of China

Jiang Yongqiang, Fuyang General Distillery, Fuyang, Anhui Province 236018, People's Republic of China

Abstract

With the assistance of foreign and domestic experts, work on cleaner production was carried out at the Fuyang General Distillery from March to December 1994, beginning with a CP audit. This audit and the CP options examined are described in detail in this article. The results of economic and environmental feasibility analyses are also presented. There are several hundred large polluting plants in the Huaihe River Basin, of which approximately a hundred are distilleries. The article addresses the prospects for promoting CP in these distilleries.

Résumé

De mars à décembre 1994, la Distillerie Générale de Fuyang, en collaboration avec des experts chinois et étrangers, a travaillé à la mise en œuvre d'une production plus propre. Elle a d'abord réalisé un audit dont les résultats sont repris en détail dans cet article, de même que les études de faisabilité économique et écologique. Des centaines de grandes usines polluantes, dont près d'une centaine de distilleries, sont installées dans le bassin de la rivière Huaihe. Cet article examine les perspectives de développement d'une production plus propre dans ces distilleries.

Resumen

Con la asistencia de expertos nacionales y extranjeros, se efectuaron trabajos sobre producción limpia (CP) en la Destilería General de Fuyang de marzo a diciembre de 1994, comenzando por una auditoría sobre CP. En este artículo se describen en detalle dicha auditoría y las opciones de CP examinadas, y también se presentan los resultados de los análisis de viabilidad medioambiental y económica. Existen varios cientos de grandes plantas industriales contaminantes en la cuenca del río Huaihe, de las cuales, unas cien son destilerías. Este artículo se centra en las perspectivas de promocionar CP en estas destilerías.

Brief introduction of the enterprise

Founded in 1949, the Fuyang General Distillery (FGD) is located in the Lotus Economic Development Zone southeast of Fuyang City, Anhui Province, to the south of the Yinhe River. With an area of 150,000 square metres, it has 36 million yuan (RMB) worth of fixed assets and 1650 employees, including 138 technicians accounting for 8.4 per cent of total employees. It has 13 workshops and nine management divisions. Between January and November 1994 the value of its industrial output reached 103.7 million yuan (RMB), with sales profits of 153.15 million yuan (RMB) and profit tax of 32.66 million yuan (RMB). Net profit was 8.11 million yuan (RMB).

The present situation in regard to alcohol production and environmental protection

The alcohol workshop has 121 staff, including six management personnel. The director of the workshop directly takes charge of all affairs in the workshop. Each worker's salary is calculated according to his production. The raw material is sweet potato, and energy is provided mainly by steam and electricity. The workshop can produce 20,000 tonnes of consumable alcohol, with a total industrial value of 72 million yuan (RMB), per year.

Emissions

The main waste of FGD is from alcohol production. The organic pollutants from alcohol production account for about 90 per cent of FGD's total organic pollutants. The emissions of alcohol production principally contain:

Fermentation slops

For each tonne of alcohol production, the fermentation slops amount to roughly 14 tonnes. Each year there are about 280,000 cubic metres of fermentation slops resulting from alcohol production. COD and BOD load are 54,000 mg/l and 26,000 mg/l, respectively, which equals 15,120 tonnes of BOD and 7280 tonnes of COD a year.

Wastewater

The wastewater is mainly cooling water and washing water. In general, the production of one tonne of alcohol requires 64 tonnes of fresh water (not containing recycled water). About 1.28 million tonnes of wastewater, containing a little BOD and COD, results from alcohol production each year.

Solid waste

The solid waste is mainly coal slag from a boiler house that consumes 22,000 tonnes of coal per year. The coal slag output is 7500 tonnes per year.

Waste gases

The output of waste gases, mainly from an

industrial boiler, amounts to 180,000,000 cubic metres/year. They contain a lot of product and S-gas.

Treatment and disposal of pollutants

Fermentation slops

There are two end-of-pipe systems to treat fermentation slops: anaerobic fermentation to produce methane, and fermentation slop culture to produce funiculus protein.

Anaerobic fermentation to produce methane

In 1985 and 1992, FGD invested 1.22 million yuan (RMB) to build two methane fermentation tanks, each of which has a 500 cubic metre capacity; one methane fermentation tank with a 1000 cubic metre capacity; and one methane vessel with a 400 cubic metre capacity. The designed treatment capacity of this system is 350 cubic metres of fermented slops/day. However, the actual treatment capacity is only 250 cubic metres of fermented slops/day because the methane is for domestic use only. Therefore, if the system works normally, a lot of methane is not effectively utilized and has to be emitted into air. The amount of treated fermentation slops is only 80,000 cubic metres yearly. The reductions in COD and BOD are 88 per cent and 83.5 per cent, respectively. Each year there is a reduction of about 3800 tonnes of COD and 1736 tonnes of BOD. But COD and BOD are still very high, about 7050 mg/litre and 4680 mg/litre, respectively.

Fermentation slop culture to produce funiculus protein

The waste of this system is recycled during alcohol production and a little is discharged periodically. FGD has studied the slop culture to produce funiculus protein and chosen FJ-84 fungus since 1984. In 1989 and 1992, FGD invested a total of 3.2 million yuan (RMB) to set up a funiculus protein workshop to treat fermentation slops, with a treatment capacity of 300-400 cubic metres/day. But it has not operated normally because the separation and drying equipment cannot meet the designated requirements and the protein content of the fodder produced is only about 20 per cent (as fermentation slops contain less protein). Hence, it is very difficult to sell it and the running fee is very high.

Solid waste coal slag

The coal slag is sold directly to produce brick and other building materials.

Waste gases

100,000 yuan (RMB) was invested in 1992 and 1993 to construct a Runner Stone Water Film installation to purify the waste gases. After being

Food Processing

Table 1
Collection of CP options

Type	No.	Name	Main points and principles
R. of R.W.	F1	use corn as the main raw material	adapt to the change in crop type, utilize waste comprehensively, reduce pollution
	F2	concentrated mash fermentation	reduce water, energy usage, decrease pollutant load
Technical modification	F3	modify grinding system	reduce the loss of R.M. and energy consumption, increase usage ratio of equipment
	F4	modify secondary cooling system	reduce pipe resistance, increase cooling effect
	F5	install more measuring apparatus	optimize process, stable process parameter
	F6	choose special yeast *	stable production, increase usage ratio of equipment and alcohol output ratio
	F7	multi-tower differential distillation	save energy, increase the quality of product
	F8	adopt computer control distillation system	optimize process control, stable operation, save energy
	F9	mend process and operation rules	check process parameter, standard operation
	F10	technical training	increase staff professional skill and problem-solving ability
	F11	prevent leakages	save R.M., energy and water
	F12	control washing water usage	save water
Equipment management	F13	maintain equipment regularly	increase equipment's usage ratio, reduce running and mending cost
	F14	guarantee the quality of R.M.	increase alcohol production ratio
	F15	strengthen R.M.	reduce R.M. loss and pollution
	F16	prevent corrosion inside fermentation tank storage	prolong tank's service life, save steam and washing water
	F17	build large shelter for fermentation tank	improve operation condition, save cooling water
	F18	make methane equipment work in full load	increase equipment's usage ratio, reduce pollution
	F19	recycle cooling water	save water, reduce wastewater
	F20	use water from slops in production	save fresh water, reduce pollution
Waste recovery	F21	recovery waste heat from fine distillation	reuse waste heat suitably
	F23	use slops to produce methane, use methane to generate power	reduce pollutants, reuse waste
	F24	use fermentation slops to produce funiculus protein	produce fodder, reduce waste and recover, and utilize slops
Note:		R.M.=raw material R. of R.M.= replacement of raw material *: This yeast can stand high alcohol	

treated, the waste gases reach the national environmental emission quality standard. However, the washing water still has some pollution problems.

The above analysis indicates that although FGD has devoted a great deal of money and manpower to end-of-pipe (EOP) control in the past, the pollution prevention results are not so good. In order to reduce pollution as far as possible and protect the environment, it is very necessary to adopt cleaner production.

Cleaner production audit

Cleaner production (CP) is achieved through executing a cleaner production audit. Through auditing the data on production are checked, the problems and their causes are found, and some measures to resolve the problems are developed and implemented. All these can increase enterprises' economic and environmental benefits. It is lucky for FGD to be chosen one of the first

batch demonstration enterprises in the Subproject B-4, "Promoting China Cleaner Production". With the aid of foreign and domestic experts, cleaner production was carried out fruitfully from March to December 1994.

The start of Cleaner Production (CP)

Before undertaking CP, FGD had assigned people times to attend national CP audit training classes in Beijing. The CP audit officially began in late March 1994. Suo Bingxun, director of FGD, showed great interest. Under his lead, the cleaner production audit group was soon established. He organized a cross-mobilization meeting on CP and asked all employees to participate in it and work together. Simultaneously, he assigned Mr Jiang Youngqiang, vice-director of FGD, to take charge of the CP audit with full powers. These actions guaranteed the CP audit's success.

In late March and mid July 1994, foreign and

Chinese experts visited FGD and conducted CP audit work. They also gave several lectures presenting CP statements from throughout the world and discussed a number of questions raised by the employees. Their efforts were very encouraging for staff. Then the CP audit group handed out some materials on CP to all staff, which allowed them to understand the real meanings of CP and overcame a variety of obstacles. This work helped the CP audit run smoothly.

Assessment and option generation

Assessment

As soon as dissemination and mobilization were completed, the CP audit started on-site investigation. Beginning with the raw material, they audited and carefully checked all data on techniques, equipment, material and energy consumption, waste emissions, and products. At the same time, they discussed and analysed existing problems with technicians and workers in batches. Based on the results of on-site investigation and discussions and analyses, six alternate audit focuses were decided. One of them, the alcohol workshop, was chosen as the audit focus by the weighted sum method (WSM). After choosing the audit focus, the group performed a variety of measures and tests, as well as theory calculation, with the help of other organizations.

The inputs and outputs of material and energy were checked carefully, and the material balance and energy balance were set up. A lot of problems were found, mainly including: the management rule is not complete; the process technology is not perfect; the operation does not match the order; there are not enough measurements to test and check process data; some raw material is lost, and raw material contains high impurities; the wastewater is not recycled very well; a lot of waste heat is not used; the recovery of waste is not so good; some equipment is old and does not work well; the process level is low; the quality of product always stays within the common consumption standard, which is far from a high quality standard.

According to the analysis above, and considering FGD's actual statements and following the requirements that the water quality of all main-streams and branches in the Huaihe River Basin must become clear by the end of 1997, these prevention pollution targets have been decided: Short-term (by June 1995): 1) reduce COD by 30 per cent; 2) reduce water consumption by 25 per cent.

Mid-term (by the end of 1998): 1) reduce COD load by 65 per cent; 2) reduce steam consumption by 25 per cent.

Developing CP options

By mobilizing all employees, the CP group collected 102 suggestions and options. After analysing them, the group chose 24 as the audit's focus. Their general outline is given in Table 1. Among 24 options, ten belong to none/low-cost options accounting for 45.8 per cent of total options, five belong to middle-cost options,

accounting for 20.8 per cent; and eight belong to high-cost options, accounting for 33.3 per cent. Among a total of 24 options, five are closely related to energy, accounting for 20.8 per cent.

F1 and F23 are high-cost options and were not considered for implementation because of raw material limitations. More research on these options should be done in the future. F3, F4, F5 and F6, having a close relation to F2, are feasible. These five options are combined in one option, F2F. F8 and F22, closely related to F7, are also feasible. F7 combines F8 and F22 to form option F7F. After being selected, the feasibility of F2F, F7F and F23 is analysed in detail.

It can be seen from the above that, among 24 options, 16 are none/low and mid-cost options, accounting for 66.6 per cent of the total options. Thirteen of the 16 have been implemented. Among these 13 options, nine have been implemented with the investment of 420,000 yuan (RMB) and the benefits of 1.43 million yuan (RMB)/year. Four of them are being implemented. It is estimated that 0.28 million yuan (RMB) will be invested in these four options and 0.25 million yuan (RMB)/year will be gained. By the time all 13 options have been implemented, 1.68 million yuan (RMB)/year can be gained and COD load will be reduced more than 30 per cent, meaning a reduction of more than 4500 tonnes of COD per year. At the same time, there will be a saving of fresh water of more than 25 per cent. Options F3, F6 and F22 will be implemented with high-cost options.

The feasibility analysis of high-cost options

The Technical Feasibility Analysis F2F is a combined option with the main option F2. The principle change in technical process is the proportion of raw material to water, from 1:3.3 to 1:2.8. In this change, the yeast standing high alcoholicity should be chosen and the water recycling of fermentation slops can be increased from 20 to 35 per cent. Simultaneously, the grinding system and the secondary cooling system will be improved together and some detecting and measuring equipment will be installed as well. These improvements are good for decreasing the loss of raw material, reducing the resistance of material flow, and making the process parameter stable and of optimum efficiency. This technique has been used successfully by several large domestic distilleries. Therefore, it is reliable and not only reduces the consumption of raw material as well as the output of pollutants, but also increases the usage ratio of equipment and the output of products. F7F is a multi-tower differential distillation option. The main advantages of this option are that the waste heat can be effectively utilized, steam and cooling water are greatly saved, high-quality alcohol can be produced, and wastes are reduced noticeably. This technique is very popular in other countries, and several enterprises are using it in China. It is a quite advanced and mature technique. F23 is to get the methane from fer-

mentation slops to generate electric power. The main idea is to make full use of our methane fermenting equipment to develop new energy (electric power) which will be used in the production process. Methane generators have been produced by many factories. Some enterprises have used these generators very successfully. Hence, it is a dependable technique.

Economic feasibility analysis

The results of the economic feasibility analysis of implementation of three options are presented in Table 3.

Three important options are feasible economically. In accordance with the capital investments and FGD's actual statements, it is recommended that F2F and F7F are implemented at the same time. After these two options operate one year, F23 will begin to run by using the economic benefits gained from implementing F7F and F2F. It is estimated that only in three years can all investments and interest be returned.

Environmental feasibility analysis

When F2F is implemented, 15 per cent steam and cooling water can be saved and there can be a 25 per cent COD reduction. When F7F is implemented, 30-40 per cent steam and about 30 per cent cooling water will be saved in the distillation process. At the same time, the pollution load and wastewater output of the heating system, as well as the output of fermentation slops, is reduced appreciably. When F23 is

implemented, the COD load can be reduced by about 14 per cent and waste will be recycled suitably. As soon as the three options are implemented, the COD load will be reduced by about 40 per cent.

Comparison of pollutants before and after adopting CP

The comparison of pollutants before and after executing CP is shown in Table 4. The table indicates that the steam and fresh water consumption per tonne of alcohol can be reduced more than 30 per cent, while the COD load of fermentation slops can be reduced 69 per cent based on the original output. This means the COD load of alcohol production can be decreased by 94 per cent. The last 6 per cent remains in the methane digestive. In order to reduce this 6 per cent of pollutants as far as possible, some special research will be done later.

Summary

1) By CP audit, we found problems existing in our enterprise and developed a variety of management and technique innovation options which are suitable to FGD's actual statements. The whole quality of the enterprise has increased greatly.

2) A CP audit gains the results expected and increases the benefits in economics and environment dramatically. After implementing none/low and some mid-cost options, COD load has been reduced 30 per cent and the consumption of fresh water per tonne of alcohol has been

Table 2
The results of implementing CP options

No.	Cost class	Investments	Implementation time	Environmental benefits	Economic benefits
F9	low	20	94.4	reduce COD 6%	save coal 1000 tonnes, save 200
F10	low	20	94.5	potential	potential
F11	low	30	94.4	reduce COD 2%	save 50
F12	none	-	94.4	reduce wastewater	save 10
F13	low	20	94.4	potential	save 40
F14	none	-	94.4	reduce impurity	save R.M. 900 tonnes, save 720
F15	medium	280	94.4-94.6	reduce R.M. rot, loss and pollution	save R.M. 300 tonnes, save 240
F16	medium	100	94.8-95.3	reduce washing water	potential, prolong five-year life
F17	medium	120	94.10-95.4	reduce wastewater	save water 60,000 t/y, save 30
F18	low	20	94.9	reduce COD 10%	save effluent fee 120
F19	low	30	94.10-95.3	reduce water 400,000 tonnes/y	save water 400,000 t/y, save 200
F20	low	30	94.11-95.3	reduce COD 14%	save water 40,000 t/y, save 20
F21	low	30	94.10-94.12	reduce heat system pollution	save coal 250 tonnes/y, save 50
F22	low	planned to be implemented with F7			
F3	medium	planned to be implemented with F2			
F6	medium	planned to be implemented with F2			

Note: investments = *1000 (yuan RMB)
saves = *1000 (yuan RMB/year)

Food Processing

Table 3
Economic index of three important options

Economic Index	F2F	Option F7F	F23
Capital investment (million yuan RMB)	1.752	5.192	1.644
Savings in operating cost (million yuan RMB/year)	0.812	2.84	0.438
Annual extra cash flow (million yuan RMB/year)	0.8353	2.5933	0.5668
Payback period (year)	2.1	2.0	2.9
Net present value (million yuan RMB)	3.2356	18.2153	1.7404
Internal rate of return (%)	45.28	48.99	29.92

decreased 28 per cent, which can bring economic benefits of 1.68 million yuan (RMB)/y. If the important options are implemented, COD load will be reduced 40 per cent more and steam consumption per tonne of alcohol will be reduced 30 per cent more. At the same time, a great deal of cooling water will be saved. The annual extra cash flow is about 4 million yuan (RMB). It realizes the same economic and environmental growth.

3) CP helps us change the old idea of paying more attention to EOP and begin to prevent pollution from the total production process.

4) Through CP, there is training in the CP audit. The CP concept and significance are correctly understood.

Experience and lessons

1) CP is an inventive system and a brand new way of looking at things. It is good for widening the thoughts of management persons and workers.

2) CP can help developing countries set up a better industrial pollution control system so as to avoid going down the old road of "pollution first, treatment later".

3) CP is an important method to increase the management level and

competence of an enterprise.

4) CP is the best means for an enterprise to develop an optimum technical innovation option.

5) All persons in an enterprise should participate in CP. Finding problems starting from the lowest and most basic levels is an important feature.

6) CP is the optimum way to realize both economic and environmental benefits. It will reduce pollution and obtain economic benefits more effectively than EOP.

The prospect and feasibility of promoting CP in the Huaihe River Basin distilleries

The main polluting industrial sectors in the Huaihe River Basin are chemicals, paper making, tanneries, breweries and distilleries. There are several hundred large polluting plants in the Huaihe River Basin. About 100 of them are distilleries. Their output of alcohol is about 1 million tonnes/year with 14 million tonnes/year of fermentation slops. Most of these distilleries are medium and small enterprises whose management level and technical condition are very poor. They often ignore the importance of pollution control, and their prevention pollution measures are bad.

Since the State Council of China ordered that, by the end of 1997, the water quality of all mainstreams and branches in the Basin must become clear, in order to realize this general goal all governments at all levels in the basin are

carrying out research and designating prevention pollution targets within a limited period.

It can be seen from the foregoing analysis that promoting CP in the Huaihe River Basin at present has a very good chance and its prospect is very wide. Based on the results of CP at FGD, analysing related factors to widen CP and considering the differences between each enterprise, we suppose that CP will reduce COD 40 per cent, and steam as well as cooling water 10 per cent, respectively, when CP is promoted in the Huaihe River Basin. Each year, a COD reduction of about 300,000 tonnes will take place, along with a savings of about 80,000 tonnes of coal and 5 million tonnes of cooling water (all computed based on 1 million tonnes of alcohol production yearly). Both economic benefits and environmental benefits are great. And this makes environmental investments seem more reasonable and is good for promoting CP in the Basin quickly.

Acknowledgements

We are grateful to the World Bank for their financial aid to this project, and to the China National Environmental Protection Agency (NEPA) and the Chinese Research Academy of Environmental Sciences (CRAES) for their concern and support. We also sincerely wish to acknowledge all these experts' help: Mr John Kryger, the Industry and Environment Office of the United Nations Environment Programme; Mr Niels Chr. Madsen, DANBREW, Denmark; domestic experts Ms Li Zhuodan, the Environmental Science Institute of the Ministry of Light Industry, and Mr Zhang Jiugen, Environmental Management Institute, CRAES.

References

1. NEPA, *The Manual for Enterprise CP Audit* (trial version). Beijing, 1994.
2. NEPA, *CP Measuring News in Brief*, No 3. Beijing, 1994.

Table 4
Comparison of pollutants before and after CP

Pollutants	Original output	Before CP	After CP	Reduced by CP
COD load (%)	100	75	6	69
COD (tonnes/year)	15120	11320	1007	10313
W.W. load (%)	100	100	61	39
W.W. (M. tonnes/year)	1.28	1.28	0.78	0.5
C.S. load	100	100	73	27
C.S. (M. tonnes/year)	0.75	0.75	0.55	0.20

W.W.= Wastewater
C.S.= Coal slag

Chlorine compounds, food safety and the environment

Robert L. Garfield, Vice President, Regulatory and Technical Affairs, American Frozen Food Institute, 1764 Old Meadow Lane, McLean, Virginia 22102, USA

Chlorine compounds used for cleaning purposes in the food industry have become a focus of environmental debate in the United States. To review the uses of chlorine in the food industry and its environmental implications, we have asked Robert L. Garfield, Vice President of Regulatory and Technical Affairs at the American Frozen Food Institute, to give his point of view.

Chlorine and chlorine derivatives are effective sanitizing agents which help protect raw and processed food supplies worldwide. Every year approximately 12 million tonnes of chlorine is produced in North America.¹ Food sanitation is one important use of this chemical, along with purification of drinking water, wastewater disinfection, manufacturing of pharmaceuticals, and approximately 96 per cent of crop protection chemicals.

Historically, manufacturers of food products as diverse as raw meat, poultry and vegetables have used chlorine and chlorine derivative washes prior to processing. These chemicals have been shown to be effective against growth of foodborne pathogenic bacteria. For example, research has shown that chlorine dioxide disrupts protein synthesis in *Escherichia coli*,² and chlorine sanitizing solutions are effective in reducing *Salmonella* contamination levels in chicken, fruit and vegetable products.³ Recent outbreaks of foodborne pathogens in the United States and other countries demonstrate the importance of effective sanitization in food processing.

Chlorine and chlorine derivatives are also important clean-up tools, in circumstances where every square inch of a food contact surface must be cleaned and sanitized. The United States' Grade A Pasteurized Milk Ordinance (PMO) declares that either calcium or sodium hypochlorite is a satisfactory chemical sanitizer, and exposure time of at least one minute to at least 50 ppm available chlorine should be maintained. Further, the PMO indicates other sanitizers should be prepared at concentrations such as to provide bacterial effectiveness equivalent to that of hypochlorite solutions at a concentration of 50 ppm of available chlorine.⁴ The US Food Code, a model for safeguarding public health and assuring that food service and retail food are unadulterated, suggests all equipment be chemically sanitized by providing at least ten seconds for chlorine solutions or at least 30 seconds for other chemical sanitizers.⁵ The US Food and Drug Administration prescribes concentrations and pH of chlorine solutions as shown in the chart.

Bactericides and sanitizers, including chlorine, chlorine compounds, iodine or bromine compounds, and quaternary ammonium compounds, are not benign. The function of these compounds is to help eliminate pathogenic and spoilage microorganisms whose presence is inherent in a food processing environment. Chlorine and chlorine derivatives, in particular, have become a focus for environmental concern, and some environmental groups suggest a phase-out of chlorine use globally. The United States Environmental Protection Agency (US EPA) has initiated studies and rulemaking which support that direction.

The US EPA recognizes the importance of chlorine-based chemicals such as chlorine dioxide, as evidenced by its stating that "Chlorine dioxide is an effective disinfectant."⁶ Yet the agency has proposed a reduction in the maximum residual level of chlorine in primary drinking water in the US to 4.0 mg/l on a running annual average, and of chlorine dioxide to 0.8 mg/l on a daily sampling basis. Since its primary drinking water regulations focus on municipal water supplies, one could argue that the US EPA proposal does not impact the food industry. However, the US Department of Agriculture (USDA) requires as a minimum that food plant water supplies pass tests prescribed for potability in the National

Interim Primary Drinking Water Regulations promulgated by the US EPA. USDA states that "Water from any source not approved and certified as potable is automatically deemed non-potable."⁷ Thus the proposed regulation could be problematic to US meat and poultry processors and other segments of the food industry.

Other cleaning agents important to the food industry have also been affected by regulatory action. Methyl bromide is an example. Banned as a Class I ozone depleter under the Clean Air Act of 1990, methyl bromide production will be phased out during the next few years. To date, no safe and effective alternative to methyl bromide exists for fumigating agricultural products imported into the US. The implications for domestic production agriculture could be disastrous if a safe alternative is not found prior to the phase-out date. Ultimately, foreign raw and processed agricultural products suspected of containing a foreign pest that is not indigenous to the US could be banned.

The US Congress did not have domestic or imported agricultural products in mind when it crafted the Clean Air Act of 1990. However, the minor but important use of methyl bromide as a fumigant for imported fruits and vegetables was a victim of language in the Act which called for broad-brush environmental policy without appropriate risk assessment. A similar fate could befall specific chlorine usage, especially if the Clinton

Administration continues to support its intention to "develop a national strategy for substituting, reducing, or prohibiting the use of chlorine and chlorinated compounds."

The example of methyl bromide shows that, as an unintended consequence of environmental regulatory and/or legislative policy, chemicals critical to an industry can be phased out without appropriate

assessment of their risks and benefits to society. Returning to the case of chlorine, the future use of this chemical worldwide must be evaluated on the basis of a comparison between the risk it presents to society and the benefits society may derive from it. Those pundits who seek its use must take into consideration the countless lives protected and the sickness prevented since chlorine use was begun during World War I. Curbing or banning the use of chlorine and chlorine derivatives, the most widely used and effective group of food sanitizers, would be imprudent.

Chlorine solution concentrations and temperatures for washing equipment

Minimum concentration mg/litre	Minimum temperature	
	pH 10 or less °C(°F)	pH 8 or less °C(°F)
25	49 (120)	49 (120)
50	38 (100)	24 (75)
100	13 (55)	13 (55)

Source: US Food Code, 1993

References

1. The Chlorine Institute (1994) *Chlorine, Does a World of Good*.
2. Bernarde, M.A., Isreal, B.M., Olivieri, V.P. and Grannstrom, M.L. (1965) Efficiency of chlorine dioxide as a bactericide. *Appl. Microbiol.* 13:776-780.
3. Park, D.L., Rua, Jr., S.M. and Acker, R.E. (1991) Direct application of a new hypochlorite sanitizer for reducing bacterial contamination on foods. *J. Food Prot.* 54:960-964.
4. US Food and Drug Administration (1985) *Grade A Pasteurized Milk Ordinance*. Appendix F-133-135. Government Printing Office, Washington, D.C.
5. US Food and Drug Administration (1993) *US Food Code*. 4-703.11. Government Printing Office, Washington, D.C.
6. Cotruvo, J.A., Director, Criteria and Standards Division, US EPA. 25 November 1981 letter to Rio Linda Chemical Company.
7. Food Safety and Inspection Service, US Department of Agriculture (1982) *Sanitation Handbook for Meat and Poultry Inspectors*. Ch. 13-3.0. Government Printing Office, Washington, D.C. July.

Environmental imperatives and economic development: the Del Monte Philippines success story

I.R. Sau Obera, Media Relations Manager, Del Monte Philippines, Inc., Bugo, Cagayan de Oro City, Philippines

Abstract

Del Monte Philippines was one of eight companies which received an award from the government of that country in 1994 for outstanding contributions to the protection and preservation of environmental resources. Del Monte, the only multinational corporation so honoured, was cited for its construction of a new state-of-the-art aerobic wastewater treatment system. Through the Industrial Environmental Management Programme, government and business have agreed to support each other's efforts to promote waste minimization and reduce industrial pollution.

Résumé

Del Monte Philippines est l'une des huit sociétés primées en 1994 par le gouvernement de ce pays pour leur contribution exceptionnelle à la protection et à la préservation des ressources environnementales. Del Monte, seule multinationale parmi les lauréats, a été récompensé pour la construction d'un nouveau système aérobie ultramoderne de traitement des eaux usées. Dans le cadre du Programme de gestion de l'environnement du secteur industriel, l'Etat et des entreprises se sont engagés à unir leurs efforts en faveur de la réduction des déchets et de la pollution industrielle.

Resumen

Del Monte fue una de las ocho empresas galardonadas por el gobierno de Filipinas en 1994 por su importante contribución a la protección y preservación de los recursos medioambientales. Del Monte, la única corporación multinacional tan homenajeada, fue citada por la construcción de un nuevo sistema de tratamiento de aguas residuales aeróbico con tecnología punta. El gobierno y las empresas han acordado apoyar los esfuerzos mutuos para promocionar la disminución de los desechos y reducir la contaminación industrial mediante el Programa de Gestión Medioambiental Industrial.

In July 1994, Del Monte Philippines, Inc. in Bugo, Cagayan de Oro (on the southern island of Mindanao) received a plaque of recognition from the Philippine government citing its contributions to the protection and preservation of the country's environmental resources. Del Monte was one of the eight companies so honored – and the only one among multinational corporations doing business in the Philippines.

The award came in the wake of the government-sponsored Industrial Environmental Management Programme (IEMP). Through the IEMP, a responsive government and a responsible business institution agreed to support each other's programmes to promote waste minimization and fight industrial pollution.

While effective waste minimization and proper resource management cut deep into the heart of the problem of industrial pollution, technology delivers the *coup de grace*. Del Monte was also cited for constructing a new, state-of-the-art, aerobic wastewater treatment system. The new facility reduces BOD in the company's wastewater discharge to levels significantly below government requirements.

♦♦♦

In July 1994, the Philippine Department of Environment and Natural Resources cited eight companies (out of the thousands doing business across the archipelago) for their outstanding contributions in the area of environmental conservation. The prize was a small plaque worth no more than ten dollars. But in a country that has lashed back at the evil of environmental degradation with one of the world's most stringent environmental laws, the award was priceless. It brought to the honorees incalculable prestige and respect from the most fearsome gadflies of environmentalism – the Philippine NGO's.

Of the eight companies so honored, only one was a multinational corporation: Del Monte Philippines, Inc. Del Monte was cited for its successful waste minimization programme and for investing in a \$ 4.2 million state-of-the-art aerobic wastewater treatment plant soon to be inaugurated on the island of Mindanao.

Del Monte's sterling achievement glows more brightly when viewed from the environmental imperatives almost peculiar to the Philippines. The country is an archipelago comprised by more than 7000 islands. Between the South China Sea to the west and the Pacific Ocean to

the east, the country has eight seas teeming with navigational commerce and marine life. The total length of the country's coastlines is roughly 35,000 kilometers. Around 100 plant and 800 animal species inhabit Philippine salt waters. Pollution from industrial and domestic sources has threatened many of these species with extinction. Under pressure to preserve its archipelagic resources, the country has instituted one of the world's most encompassing and strictest marine anti-pollution laws. One of these laws defines the upper limits of biochemical oxygen demand (BOD) from industrial wastewater discharge.

The full weight of these laws falls on the shoulders of coastal industries such as Del Monte's pineapple-processing plant located along Macajalar Bay, the most important northern coastline of Mindanao, the country's second largest and southernmost island.

Macajalar Bay is an embayment of the Mindanao Sea that opens towards the northwest like an inverted bell curve (see map). From tip to tip, the arc measures 30 kilometers hitting eight municipalities – from Alubijid to the west to Belingasag to the east. The bay is home to a thriving fishing industry and around 35 percent of the fisherfolk in the province of Misamis Oriental. Precious catch from the bay includes frigate tuna, skipjack, sardines, anchovies and big-eyed scads. Sea urchin, clams, oysters, crabs, milkfish fry, and seaweeds (sargassum) are the other indigenous species commercially in demand across the region.

In Bugo, Cagayan de Oro City, southeast of the bay and overlooking crystal blue waters, Del Monte runs Asia's largest pineapple cannery. International liners which regularly call at Del Monte's deep-sea port (right beside the cannery) load a wide variety of pineapple products ranging from canned pineapple solids and aseptic juices to pineapple crush and concentrates. The cannery also processes various tomato products and low-acid bean products.

Wastewater discharge from the cannery carries mainly pineapple solid particles and dissolved solids. The old system of treating wastewater used by the company is a series of ultra-fine screens that catch the solids before the wastewater is pumped into the bay through a 300-metre submarine outfall whose Y-shaped diffuser is submerged offshore 24 metres under the sea.

Food Processing

The rise in productivity and rapid industrialization over the last decade in the Philippines, however, have compelled the government to enact stiffer environmental laws. They also rendered obsolete much of existing marine anti-pollution technology including Del Monte's primary wastewater treatment system: screening. The installation of state-of-the-art waste treatment facilities, on the other hand, requires huge capital investments, usually a process involving long and thorough discussions in corporate boardrooms. How Del Monte Philippines succeeded in meeting its environmental obligations as well as increasingly more demanding environmental laws is a story worth telling to the world. It is a story of quality partnership between a responsive government and a responsible business institution.

On September 30, 1991, a landmark agreement between the Government of the Philippines and the United States Agency for International Development (USAID) was born. It created the Industrial Environmental Management Project (IEMP) which, in effect, recognized the need to harmonize environmental imperatives with economic development through a process which may be called **dialectical environmentalism**: conserve the environment without overburdening industries, and develop the economy without degrading the environment. The process has two stages – waste minimization followed by the installation of the proper anti-pollution facility.

By organizing the IEMP, the Philippine government sent an encouraging message to industries – "We'll give you time to catch up with new and stricter environmental laws and improve your pollution-fighting capabilities. Meanwhile you can do something critically important to the conservation and protection of the environment. Further reduce your waste."

Then on the initial stages of construction of its aerobic wastewater treatment plant, Del Monte enrolled in the IEMP in June 1993. The memorandum of agreement called for the Department of Environment and Natural Resources to send a Pollution Management Appraisal (PMA) team to audit Del Monte Cannery's waste minimization programme and recommend improvements; USAID to fund the study and the documentation of the process; and Del Monte to implement the proposals of the PMA team and continue the construction of its new wastewater treatment facility.

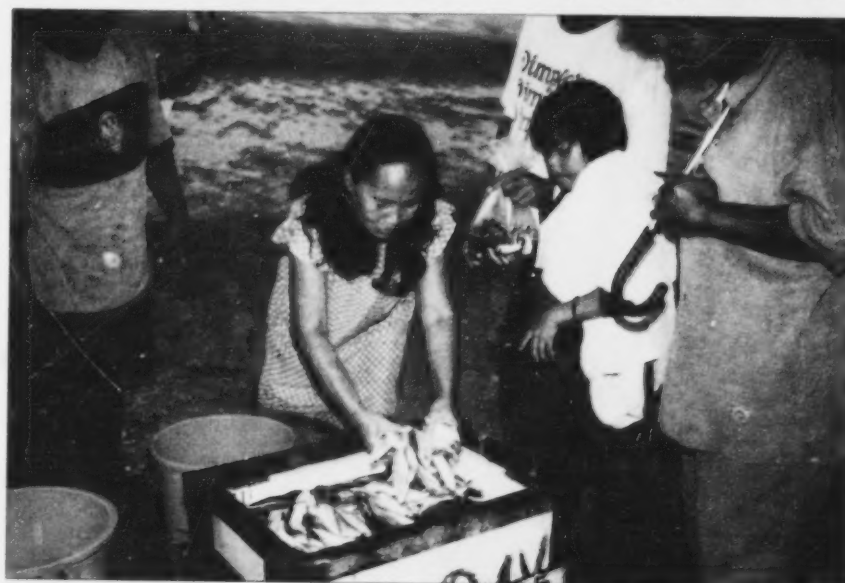
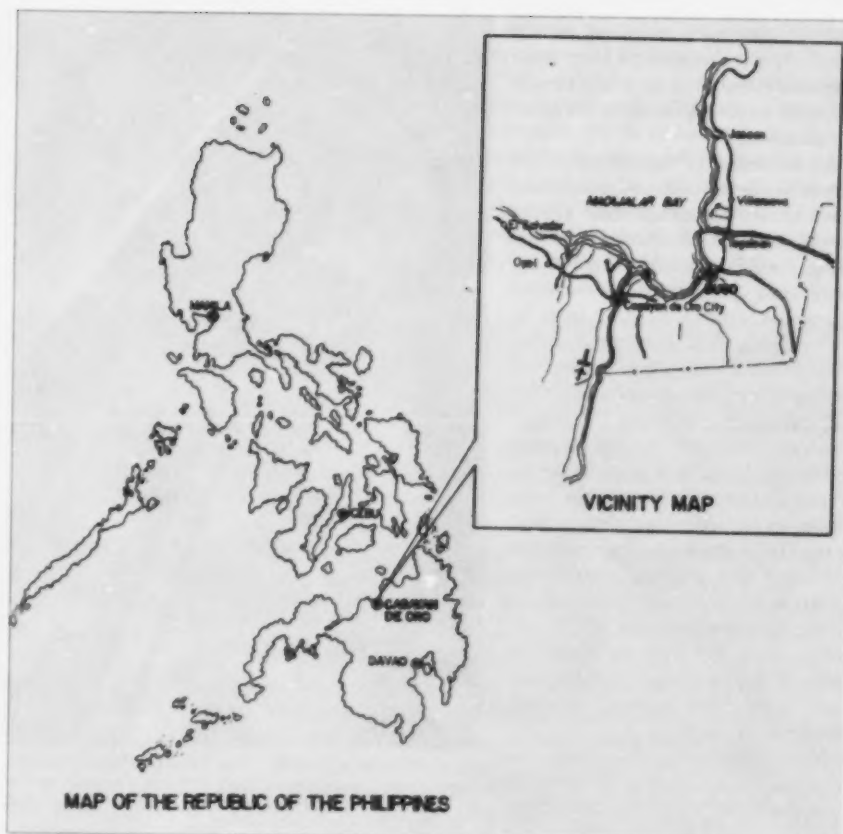
On July 15, 1993, the IEMP-PMA four-man team headed by environmental consultant Dr Bill Lacy began a three-day on-site pollution management appraisal at Del Monte Philippines Cannery. The group was assisted by the cannery's environmental management group, Taskforce 1000/1000, who derived their name from their vision: water consumption of no more than 1000 gpm and BOD no higher than 1000 milligrams per litre.

Del Monte received the PMA report on December 28, 1993. Its major recommendations included measures such as:

1. more systematic effort at recovering pineapple mixed with pulp;
2. improved water resource management to include the installation of an open channel wastewater meter to monitor usage in specific areas;
3. expanding existing projects to minimize and collect fruit drops and juice spillage;
4. improved collection and recycling of waste

cans, paper and other solid trash.

How Del Monte responded to the PMA report is by itself a lesson worth learning by Philippine industries serious about cooperating with the government in reducing waste. When it was simple enough to do what the PMA recommended, Del Monte did it (**adoption**). In some cases, the company did it by another means but



A LIVELIHOOD SOURCE. A day's catch of sardines is sold right on Macajalar Bay's shores by wives of local fishermen. Fishing continues to be a major source of income for many residents of the villages around the Bay.

Food Processing

with the same result (**substitution**). Or differently but also with the same result (**improvisation**). And in several cases it did much more (**extension**) or did it better (**elevation**).

An assessment of the company's improved waste minimization programme made around six months later yielded very promising results. At the rate it was going, the company would save per year more than \$22,000 from recovered pineapples, around \$23,000 from recovered juice drip, a thousand dollars from reduced water consumption, and around \$8000 from recycled waste.

Encouraged by the results, Del Monte's Taskforce 1000/1000 further expanded the scope of its waste minimization efforts. The team realized that the key to greater success lay in water conservation. It installed a water recycling device and automated sprayer at the papaya rotary washer in the mixed-fruit section, and an improved water reclaim system in the processing areas. But more significantly, it rerouted BOD-free water, including rain-water, into the shore to reduce the wastewater volume.

Minimization of water usage also required the installation of automatic control systems for high-volume washing,

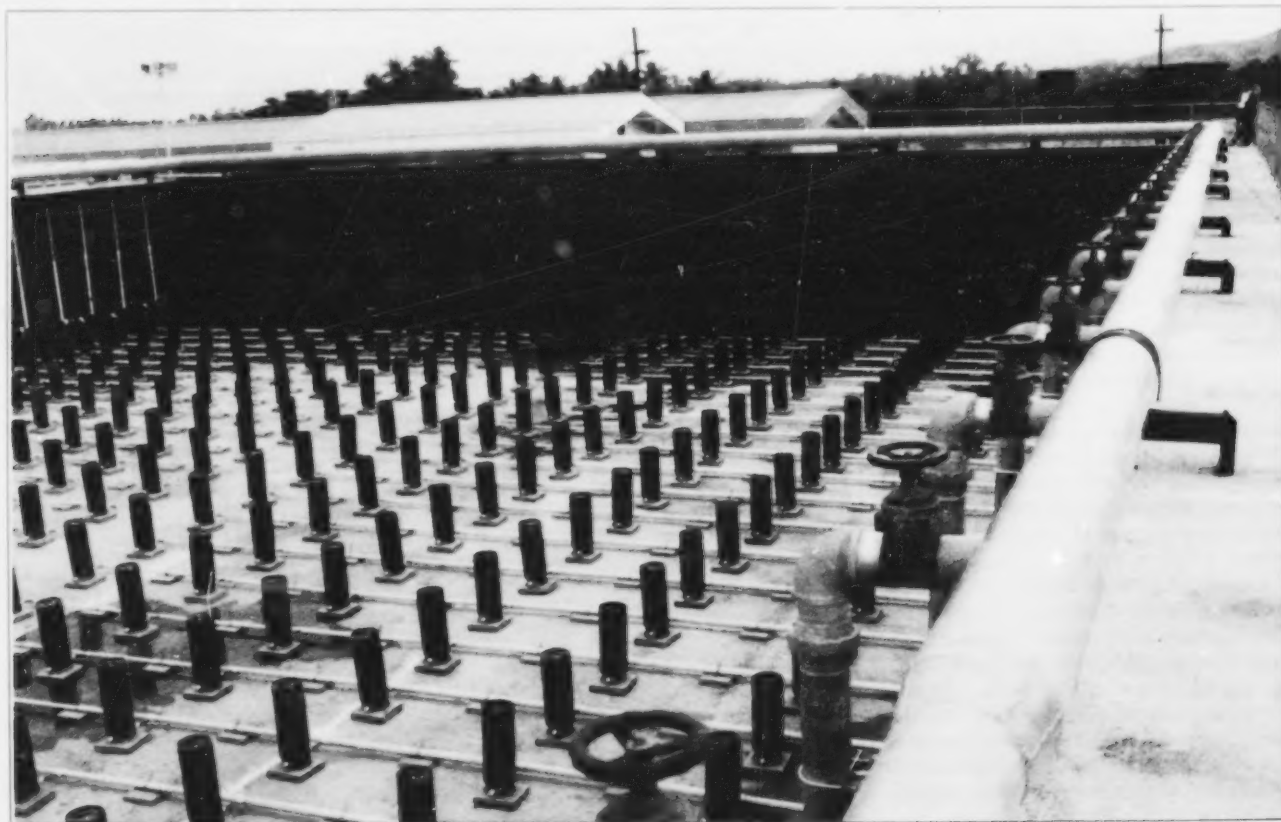


PINEAPPLE PROCESSING. Over 4000 Del Monte workers at the company's pineapple cannery in Bugo, Cagayan de Oro help process fresh pineapple into various canned products.

and water level controls in all water tanks at the production area. Replacing high-volume low-pressure hoses with high-pressure low-volume hoses also saved a lot of the precious resource. Dry cleaning was done wherever possible to remove solid waste. Scores of quick-acting shut-off valves were installed to replace conventional faucets. And all was not for naught. As of January 20, 1995, wastewater volume registered at 1400 gpm, a big drop from last year's more than 2000 gpm.

To further reduce BOD even before wastewater treatment, the taskforce has installed stainless drip collecting pans and additional rollers and chutes at the cannery's trimming and packing tables. It is amazing how such simple devices work, considering the volume of high-BOD materials caught and prevented from polluting the wastewater. The vacuum syringe section recycling line also prevents the worst BOD-carrier from seeping into the wastewater – thick liquid sugar.

The other anti-BOD measures in the process of implementation include the installation of an ultra-filtration system (which would vastly improve the cannery's filtration process and prevent juice overflows, and would eliminate the problem of



The Aerobopolis – Del Monte Philippines' wastewater treatment facility – mainly consists of three 17-foot high aeration tanks. In these tanks live the environment-friendly microbes tasked to biodegrade the organic pollutants found in the wastewater. Blowers housed on a separate shed rush air through aerators (459 in each tank), which then nurture and supply oxygen to the bacteria. The microbes attack and devour the pollutants, breaking them up into harmless elements in the wastewater.

Food Processing

filter cake disposal inherent in the old system) and an upgraded juice concentrator.

Effective waste minimization and wise resource management cut deep into the heart of the problem of industrial pollution. Less waste means less pollution. But technology delivers the *coup de grace*.

Ready for commissioning, Del Monte Philip-pines' new wastewater treatment plant in Bugo, Cagayan de Oro, built at the cost of more than

\$4.2 million, will reduce the cannery's waste-water BOD down to a level far below that required by the government. The plant's current aerobic technology can remove 97 per cent of wastewater BOD on any given day. That means that the cannery's wastewater discharge will contain BOD of only 105 milligrams per litre or less. The facility is structurally and systematically flexible, to accommodate more stringent future BOD standards to be imposed by the Depart-

ment of Environment and Natural Resources.

The plant will be fully operational on March 30, 1995, and will serve as one of the nation's marine anti-pollution showcases. Nicknamed **Aerobopolis** (for its aerobic system), it will stand by the Bay like a faithful guardian – Del Monte's quiet and yet most concrete expression of support for a whole community's vision of a life-supportive environment and in particular a clean, marine life-rich Macajalar Bay. ♦

Air emissions and food processing

Anne G. Giesecke, Vice President Environmental Activities, American Bakers Association, Suite 1290, 1350 I Street, NW, Washington, D.C. 22209, USA

People share many common resources, with no individual owner and no clear boundaries. The individual use of a common resource leads to a paradox: that individually rational choices lead to collectively irrational outcomes. Over the past 50 years, many individual choices have led to the degradation of air, water and land, and to resultant legislation to limit individual choices for the public good.

As the most visible and toxic sources of pollution have been controlled, governments have moved to control smaller sources of emissions such as the food processing industry. Food processors tend to be important users of clean water and air. This article will focus on air. Food processors should be aware of air emissions that may be classified as volatile organic compounds (VOCs), oxides of nitrogen, particulate matter and carbon dioxide.

Ethanol, for example, may be classified as a volatile organic compound. Ethanol, a natural by-product of yeast fermentation, is produced by the baking industry, the brewing industry, the winemaking industry, and the distilled spirits industry. Ethanol is a non-toxic, low reactive VOC which can in extreme summer conditions in urban areas contribute an oxygen molecule to the formation of ground ozone. The well loved aroma of baking bread carries ethanol from the oven stack, and controls have been required on the largest bakeries in the United States. The beverage producers have low levels of point-source emissions and some fugitive emissions, such as those from the storage of wooden barrels for the ageing of distilled spirits. The low emissions, technological difficulties and high cost of potential controls have usually left these sources unregulated.

Frying oil for doughnuts, potato and corn chips, and many other foods may produce VOCs; however, control requirements have not been necessary because the temperatures are not usually high enough to volatilize the oil beyond the facility walls. If temperatures are lower, the oil is usually collected in the facility as particulate matter.

Yeast manufacturing facilities may produce ethanol as well as odours and aldehydes. Some aldehydes may be considered toxic. Consideration has been given to control of the air emissions. The delivery and storage of dry ingredients such as flour should be managed in such a way that no product is lost and no particulate matter is emitted. Simple filter and collection devices are often used.

Indirect fired boilers and ovens have separate stacks for the by-products of combustion such as oxides of nitrogen, and for the oven emissions such as ethanol from yeast-raised products. Different control technologies may be necessary for different emissions. Direct fired ovens have stacks with combined emissions.

Wood fires for ovens, grills and barbecues, and the burning of oil and gas fuels, produce oxides of nitrogen. Wood fires may release particulate matter. The amount of oxides of nitrogen produced depends on the combustion temperature; the higher the temperature, the more oxides of nitrogen.

A number of new technologies have been developed to control air

emissions from food processing facilities. Low oxides of nitrogen burners have been developed for many food processor applications. There are several control technologies for VOCs such as ethanol. Heat exchangers, traditionally used for energy efficiency, are being adapted to condense a water-ethanol mixture from the oven exhaust. Biofiltration systems which have been used for odour control, and for wastewater treatment, are being adapted to treat both air and water emissions. A technology using titanium dioxide and fluorescent light to convert ethanol to carbon dioxide and water has been pilot-tested. Bacterial fermentation and pre-fermented yeast are being developed to minimize ethanol emissions, but do create carbon dioxide.

Catalytic oxidizers have been installed on about 40 bakery ovens in the United States. Oxidizers turn the oven emissions into carbon dioxide. The installation of this equipment costs each bakery about US\$500,000, and then about \$100,000 a year to operate.

In an effort to control emissions from food processors in the United States, the government has applied regulations suitable to the manufacture of chemicals and the operation of oil refineries. Although ground ozone problems are usually seasonal, the efficiencies of control technologies and governments' enforcement structures dictate that control requirements apply all the time. The result is over-regulation at costs that threaten the economic viability of many food processors.

Another important area of concern for food processors is the vehicle emissions generated by the transport of food to the market. Governments dictate vehicle fuels and traffic control measures by days of the week and times of day. Alternative fuel vehicles are being developed. In addition, in the United States employee transportation is also an issue for the employer.

In conclusion, environmental regulation is becoming increasingly complex and costly, as population growth puts a maximum pressure on our resources. When many individual people and nations want to manage a common resource, the parties with the power to control the resource must agree on the use. Also, common resources must be considered in a total environmental context; that is, discharge of a substance to air cannot simply be shifted to water. Priorities can be placed on environmental issues through the use of risk assessment and risk management. The use of sound science and cost-benefit analysis to evaluate risks is becoming an important tool for decision-makers.

Environmental management decisions have global implications. A government decision on air quality in one country has implications throughout the world. Food processors serving their local population with its cultures and tastes have been drawn into a global environment with its aggregate culture and values.

In spite of the complex social and technological challenge of environmental management, law and regulations must be real for real people and real businesses. Food processors must be part of the decision-making process, to ensure reality in government decisions.

Panorama de la lutte contre la pollution dans les abattoirs

Pierre-Yves Allard, Ingénieur industrie, Agence de l'Eau Loire-Bretagne, avenue de Buffon, B.P. 6339, 45063 Orléans Cédex 02, France

Résumé

L'article traite des principaux postes responsables de la pollution dans les abattoirs et les moyens mis en oeuvre pour la réduire avant traitement final en station d'épuration. Sont ainsi abordés:

- la collecte sélective des déjections des animaux vivants,
- la collecte sélective du sang,
- le transfert à sec des viscères et des matières stercoraires,
- la récupération des matières en suspension et des graisses des effluents.

L'efficacité de ces dispositions doit être suivie au travers de mesures portant sur la quantité et la qualité des eaux résiduaires.

Abstract

The article discusses the main activities responsible for pollution in slaughterhouses and the means used to reduce this pollution before it is finally passed on to the waste treatment plant. The following topics are discussed:

- selective collection of excrement from live animals,
- selective collection of blood,
- dry transfer of viscera and stercoraceous matter,
- recovery of matter in suspension and fat from effluent.

The efficiency of these provisions should be monitored through steps taken in regard to the quantity and quality of wastewater.

Resumen

Este artículo trata sobre los principales puntos responsables de la contaminación en los mataderos y sobre los medios puestos en práctica para reducirla antes del tratamiento final en la estación depuradora. Se abordan los siguientes temas:

- la recogida selectiva de las deyecciones de los animales vivos,
- la recogida selectiva de sangre,
- la transferencia a seco de las vísceras y materiales estercóreos,
- la recuperación de las materias en suspensión y de las grasas de los efluentes.

Se debe realizar un seguimiento de la eficacia de estas disposiciones mediante medidas sobre la cantidad y calidad de las aguas residuales.

L'analyse détaillée des postes d'utilisation d'eau et des sources de la pollution dans les abattoirs révèle le poids prépondérant de certains ateliers ou de certaines phases de l'obtention des carcasses dans la formation des rejets globaux de ces établissements.

C'est le cas, en amont de la filière d'abattage, de toutes les étapes liées à la réception des animaux vivants: déchargement aux quais de réception, aire de stockage des animaux vivants (zone de stabulation) et, corollaire obligé, atelier de lavage des camions ou des conteneurs de ramassage. En ces lieux, la pollution, fortement concentrée, trouve pour origine commune les déjections animales, que ce soit sous forme de fiente, de lisier ou de purin (voir tableau page suivante).

Autre opération toujours potentiellement ou effectivement très polluante: la saignée des animaux. La pollution est ici directement liée aux entraînements de sang (pertes ou excédent de production) par les eaux résiduaires (voir tableau page suivante).

Enfin, l'éviscération des animaux et le travail des viscères constituent le troisième pôle majeur de la pollution dans les abattoirs. Ces opérations donnent lieu en effet à une importante dissolution de graisses, de matières stercoraires et de matières fécales (voir tableau page suivante).

Si ces différentes phases (réception-stockage, saignée, éviscération) engendrent les flux de pollution les plus importants, ce sont aussi celles qui vont pouvoir donner lieu aux mesures les plus efficaces pour les réduire in situ.

Une autre disposition va pouvoir être mise en oeuvre immédiatement à la sortie des usines pour réduire les quantités de pollution à traiter en station d'épuration. C'est l'extraction des phases solides et des matières grasses que les aménagements internes n'auront pu empêcher d'être entraînées par les eaux résiduaires. Elle est obtenue par des procédés physiques de tamisage et de flottation, l'effet de ce dernier pouvant être amplifié par l'adjonction de réactifs chimiques qui font s'agréger les particules en suspension dans les eaux usées.

Les aménagements internes

Zone de réception et de stockage des animaux vivants

Quel que soit le type des animaux abattus (volailles, porcs, bovins), dans cette zone il convient toujours de s'efforcer de récupérer à sec, par raclage, le maximum des déjections animales. Ceci vaut bien sûr tant pour les camions de ramassage que pour les quais de réception ou les aires de stabulation. Cette nécessité se heurte malheureusement encore bien souvent aux habitudes acquises de tout entraîner au jet d'eau, notamment pour le lavage des camions. Néanmoins la prise de conscience des enjeux est devenue bien réelle et la tendance est effectivement au développement du raclage à sec des matières fécales solides. Celles-ci sont stockées sur une aire étanche couverte (fumière) afin d'éviter toute dissolution par les eaux de pluie. Les matières stercoraires issues de la boyauderie y trouvent également leur destination.

Les déjections liquides (lisier, purin) en provenance des aires de stabulation et les jus d'égouttage de la fumière peuvent être eux aussi soustraits des eaux usées à l'aide d'un réseau de collecte dédié aboutissant à une fosse de stockage.

Comme les fumiers, les déjections liquides sont destinées à l'épandage sur des terres agricoles (fertilisation). La reprise de ces déjections par les agriculteurs étant relativement irrégulière, il convient de prévoir une fosse correspondant au moins à un mois d'activité moyenne de l'abattoir.

Avantage de toutes ces dispositions, la pollution se trouve rassemblée sous une forme très concentrée et sous un volume réduit qu'il est techniquement et économiquement intéressant d'utiliser comme amendement agricole, sans avoir besoin de créer la capacité de station d'épuration correspondante qui se traduirait par de lourds investissements.

La saignée des animaux

A cette étape le sang est l'enjeu de la pollution et tous les efforts vont consister à l'empêcher de rejoindre les eaux résiduaires. Il faut en effet avoir présente à l'esprit l'idée qu'un litre de sang représente une centaine de grammes de DB05 (demande biochimique en oxygène en 5 jours) soit une pollution 260 fois plus concentrée que celle d'un litre d'eau usée domestique qui lui n'en contient que 380 mg.

Dans cette perspective la plupart des abattoirs se sont équipés de bacs ou de goulottes, de cir-

Food Processing

1. Si le sang n'est pas récupéré dans l'abattoir, il est responsable de la pollution suivante :

Type d'animal	Quantité de sang (en litres)	DBO ₅ (en g)	Charge polluante en équivalent habitants/jour
Bovin	300 kg	16	2100
Veau	100 kg	5	350
Ovin	20 kg	1,5	240
Porc	80 kg	4	480

2. Le transport à sec des matières stercoraires permet d'éliminer la pollution suivante :

Type d'animal	Quantité de matières stercoraires (en litres)	Transport hydraulique	à sec	Pollution éliminée DBO ₅	en équiv. hab./jour
Bovin	45	900 g DBO ₅	240 g DBO ₅	660	12
Veau	6	70 g DBO ₅	20 g DBO ₅	50	1
Ovin	5	60 g DBO ₅	16 g DBO ₅	44	0,9

3. De même, le purin à lui seul représente une certaine pollution :

Type d'animal	Quantité de purin pendant stabulation (en litres)	DBO ₅ (en g)	Charge polluante en équivalent habitants/jour
Bovin	15	270	5
Veau	3	60	1,1
Ovin	1	16	0,3
Porc	3	48	0,9

Pour empêcher la coagulation, il est administré au sang collecté

♦ d'isoler la fibrine responsable de la coagulation. Celle-ci prend en masse que l'on sépare par filtration du sang défibriné. Ce dernier trouve un débouché dans la fabrication du boudin (sang de porc essentiellement).

♦ ou un traitement chimique : ajout d'anticoagulants (citrate de sodium par exemple) à la dose d'environ 0,5 pour cent en poids. Cette stabilisation est suivie d'une préfiltration puis d'une séparation des constituants du sang par centrifugation (entre 5 et 10.000 g) entre plasma et cruor. Le cruor se compose principalement des globules rouges et blancs et des plaquettes sanguines. Il réintègre la filière sang pour alimentation animale. En revanche, le plasma trouve de larges débouchés en alimentation humaine en tant que liant dans les produits charcutiers, dans les produits de pâtisserie ou de biscuiterie...

Les machines qui opèrent cette séparation du plasma et du cruor sont des centrifugeuses à assiettes, à axe vertical, identiques à celles utilisées pour l'écumage du lait.

Eviscération et travail des viscères

Les actions engagées à cette étape pour réduire les entraînements stercoraires ou fécaux par l'eau se sont révélées très efficaces.

La substitution d'un transfert à sec à un transfert hydraulique des matières stercoraires (contenu des panses des ruminants) a permis de réduire sensiblement les rejets polluants de ces ateliers. Les moyens utilisés sont alors la pompe à piston ou le générateur d'air comprimé (canon pneumatique). L'un et l'autre produisent l'énergie nécessaire pour pousser les matières stercoraires dans des canalisations spécifiques en PVC ou en acier (100 à 300 mm de diamètre) jusqu'à la fumière. Il est préférable que le circuit de transfert soit le plus court et le plus direct possible.

Les matières stercoraires contiennent beaucoup d'eau, même après un transfert à sec. (En réalité il faut en rajouter un peu pour fluidifier et lubrifier le produit). Les abattoirs procèdent donc à leur déshydratation par pressage (presse à vis par exemple). Pour conserver toute sa logique et son intérêt à la démarche, il convient d'isoler les jus d'essorage, **très chargés en matière organique** et de leur faire rejoindre la fosse à purin de l'abattoir.

Dans les abattoirs de volailles, les viscères sont traditionnellement poussés à l'eau dans les caniveaux, jusqu'au dégrilleur de l'abattoir qui les en extrait en même temps que les autres déchets solides. Tous ces refus de dégrillage sont alors stockés en silo, puis repris par l'équarisseur.

Certaines entreprises ont mis en place des installations de vide centralisées qui, via des canalisations de collecte, vont aspirer les entrailles des animaux sous chaque machine d'éviscération. Les matières fécales n'entrent donc plus en contact avec l'eau et, par voie de fait, ne peuvent plus s'y dissoudre.

Dans les boyauderies des abattoirs de porcs, peu de progrès décisifs ont été réalisés et il faut encore solliciter l'imagination et les efforts des

cuits de collecte et de cuves de stockage du sang des animaux abattus. Ainsi s'éloigne l'époque encore récente malgré tout où le rejet des abattoirs se signalait par une coloration rouge de l'eau des rivières.

Les établissements spécialisés dans l'abattage du gros bétail collectent une partie du sang en vue de l'alimentation animale et réservent l'autre partie, bactériologiquement saine, à la consommation humaine. Mais dans le principe, l'installation de récupération du sang demeure la même.

Elle se compose :

♦ **d'un bac de saignée** en inox ou d'une aire de saignée bétonnée et carrelée où s'égoutte le sang de l'animal suspendu à un rail, en position verticale, (ou parfois allongé horizontalement sur un tapis de transport pour les porcs, la gorge tranchée surplombant le bac de saignée).

Le dimensionnement du bac de saignée a une importance déterminante. Sa taille doit être arrêtée en fonction de la cadence de la chaîne d'abattage pour correspondre au temps d'égouttage quasi complet (90 %) de la carcasse, soit 3 minutes environ.

Dans la majorité des cas, le sang collecté dans le bac de saignée est repris par pompage dans l'auge à l'aide d'une pipe plongeante. Une vidange de fond permet l'évacuation des eaux de lavage du bac qui rejoignent le circuit des eaux usées de l'abattoir.

Dans le cas d'un écoulement gravitaire du sang, le bac de saignée est pourvu d'une double bonde de sortie : une pour le sang, une pour les eaux de rinçage et de lavage. Cette bonde peut aussi être remplacée par une électrovane située sur le réseau de collecte.

♦ **d'une pompe de reprise**

Le transfert du bac de saignée à la cuve de stockage peut s'effectuer soit gravitairement (cas des abattoirs à étages) soit par pompage (pompe forte pression à piston).

Une autre technique emploie un système de dépression. La cuve de stockage et le circuit de collecte sont maintenus sous vide partiel (25 mm de Hg) permettant la reprise du sang par aspiration.

♦ **de canalisations de collecte** en acier ou en PVC de 50 mm de diamètre environ. Il est souhaitable de donner au circuit de collecte le tracé le plus simple et le plus court possible, en évitant les coudes à angle aigu pour faciliter le transit des matières épaissies contenues dans le sang (caillot).

♦ **d'une citerne de stockage** en acier, équipée de tuyauteries pour le lavage, de raccords pompiers pour la reprise du sang stocké et de témoins de remplissage pour visualiser le niveau. Le dimensionnement de la cuve (3, 5, 10 m³) est calculé en fonction :

• du volume de sang collecté quotidiennement (m³/j)

• de la fréquence de passage de l'équarisseur.

Le sang ainsi collecté par l'équarisseur subit cuisson et déshydratation et la farine obtenue, essentiellement constituée de protéines, sera incorporée à des produits d'alimentation animale.

La collecte du sang en vue de l'alimentation humaine exige des précautions accrues pour préserver sa qualité bactériologique et des dispositions particulières pour prévenir toute coagulation.

Pour éviter la contamination et la prolifération des germes, la saignée a lieu soit au trocard (instrument qui permet le prélèvement du sang directement dans les vaisseaux au niveau de la gorge tranchée) soit à l'aide d'une auge de saignée de forme particulière, qui maintient le museau des animaux à l'extérieur du bac de façon à empêcher les vomissements d'y tomber. Les matériaux utilisés doivent être de qualité alimentaire (inox, PVC alimentaire...). Enfin, le sang collecté doit être réfrigéré puis stocké dans un tank isotherme.

Food Processing

bureaux d'études et des concepteurs de matériel pour améliorer les choses. Signalons toutefois l'heureuse initiative d'un établissement qui a modifié ses files à menu (ligne de traitement des intestins grêles) pour parvenir à recycler l'eau de procédé après traitement spécifique par flottation des graisses en suspension.

Le prétraitement ou la pré-épuraton des effluents

Avant de procéder à l'épuration complète des eaux usées d'abattoir dans une station biologique en aération prolongée, seul outil suffisamment performant pour rendre les rejets de qualité acceptable pour le milieu récepteur, il est recommandé et même nécessaire d'en extraire les matières solides en suspension et les graisses. Ces éléments peuvent en effet colmater les canalisations de transfert. En outre, les graisses perturbent le fonctionnement de la station d'épuration dans la mesure où elles ralentissent les transferts d'oxygène et par conséquent la dégradation des matières organiques. Un palliatif consiste bien à augmenter l'aération des bassins, mais cela se traduit par un coût financier supplémentaire.

Des installations de prétraitement s'imposent donc bien. Elles répondent la plupart du temps au schéma classique suivant:

- ◆ poste de relevage
- ◆ tamisage
- ◆ dégraissage
- ◆ dispositif de mesure de débit et de prélèvement d'échantillons

Le poste de relevage

Bien souvent le réseau de collecte des eaux usées de l'abattoir est souterrain, situé à une cote de l'ordre de -1, voire de -2 m, et il faut envisager de relever les effluents pour les tamiser et les dégraisser au niveau du sol.

Ce relèvement peut s'opérer à l'aide d'une vis d'Archimède logée dans une auge en plan incliné en acier ou en béton et actionnée par un moteur électrique de faible puissance (4 KW pour 100 m³/h sur 4 m de hauteur).

Mais le dispositif le plus couramment rencontré consiste en une ou plusieurs pompes immergées (dont une de secours) dont le coût d'investissement est moindre que celui des vis et dont la mise en place est plus aisée.

Les pompes à roue dilacératrice sont déconseillées, car si elles broient les déchets et réduisent ainsi les problèmes de colmatage, elles engendrent aussi, ce faisant, une pollution dissoute supplémentaire contre laquelle les prétraitements sont sans effet. Il est donc préférable de recourir à des roues monocanal ou à effet Vortex qui permettent le passage des matières grossières.

Ces pompes sont installées dans un puits de relevage, généralement construit en béton (préfabriqué ou non). Leur fonctionnement est asservi au niveau du liquide dans le puits par l'intermédiaire d'interrupteurs à basculement (poires) avec contact à mercure.

Un panier dégrilleur, placé à la sortie de la canalisation d'arrivée des effluents protège les pompes en retenant les gros déchets (la maille de

cette grille es de l'ordre de 1 à 3 cm). Le panier, fixé sur des rails de guidage, est remonté régulièrement à l'aide d'une potence pour l'évacuation des déchets.

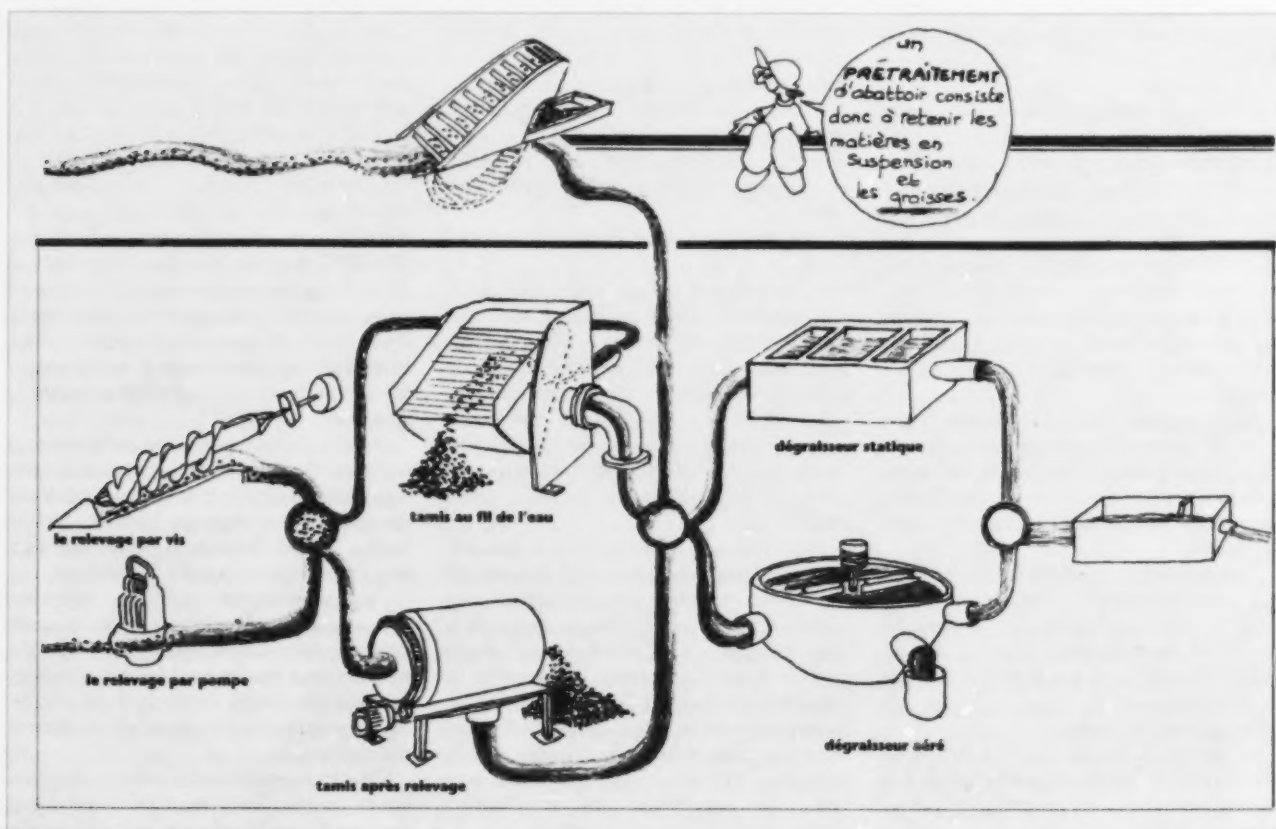
Le tamisage

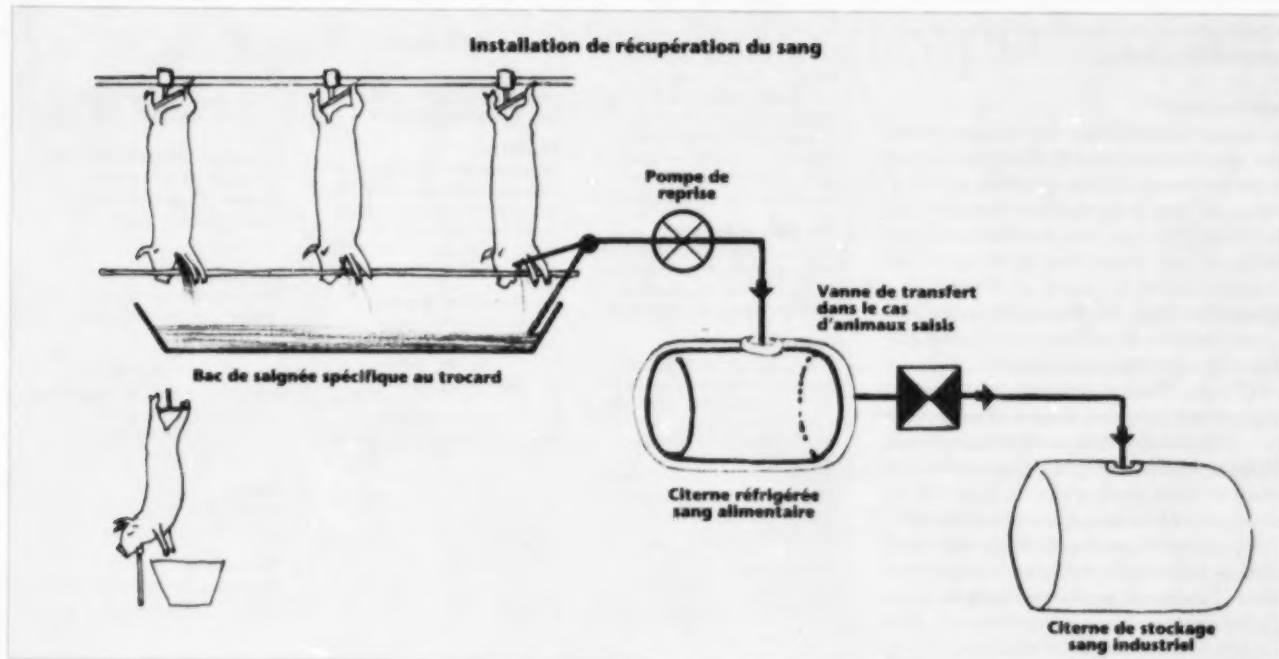
Après relèvement, les effluents sont filtrés sur des tamis de différents types pour éliminer le maximum de matières en suspension. Dans ce but on utilise des grilles à maille de l'ordre du millimètre (de 250 à 1000 ou 2000 microns). Plus la maille est fine, plus la rétention des particules est importante. Cependant, pour déterminer la taille optimale de la maille, il faut aussi tenir compte des phénomènes de colmatage par les débris et par les graisses qui figent. Les écarterments les plus souvent utilisés pour les effluents d'abattoir sont 750 et 1000 microns.

Certains tamis sont constitués d'une grille statique inclinée, alimentée à son sommet par un bac de réception. L'eau coule par surverse sur la grille inclinée et la traverse, tandis que les particules de taille supérieure aux fentes sont entraînées par gravité sur le plan incliné et tombent à sa base dans une benne de récupération (prévoir une hauteur de passage suffisante).

Les grilles peuvent présenter des ruptures de pente avec une pente forte dans la première section où a lieu la séparation solide/liquide par filtration, puis une pente moins accentuée dans la ou les sections suivantes où s'opère ainsi un égouttage des matières solides retenues par le filtre.

Il s'avère souvent nécessaire d'équiper ces





grilles de rampes de lavage (à eau chaude de préférence) pour un décolmatage périodique, voire de procéder à leur brossage une à deux fois par jour.

D'autres tamis sont mobiles, animés d'un mouvement rotatif (moteur électrique). La grille se présente alors sous la forme d'un tambour cylindrique qui peut être alimenté

- soit de l'intérieur (alimentation centrale) par une goulotte de répartition située au milieu du tambour. L'eau traverse la grille et tombe dans un bac de collecte sous le tambour tandis que les refus sont entraînés à l'extérieur par une vis d'Archimède située à l'intérieur du tambour. Une rampe de lavage et une brosse cylindrique, tangentielle au tambour, et tournant en sens inverse assurent le nettoyage du filtre.

- soit de l'extérieur (alimentation extérieure): les effluents bruts passent par surverse du répartiteur sur la partie hémicylindrique supérieure du tambour, la traversent, puis repassent à l'extérieur du tambour entraînant les refus qui auraient pu se fixer sur la grille (autonettoyage). Les particules de taille supérieure aux fentes de la grille restent à l'extérieur du tambour d'où un racloir externe les décolle et les entraîne vers une benne.

Les tamis rotatifs sont plus coûteux en investissement que les grilles statiques et réclament une maintenance plus importante (graissage des paliers...). Par contre, ils sont moins sujets au colmatage et donnent des refus de dégrillage mieux égouttés.

Il existe également des tamis au fil de l'eau, qui n'imposent donc pas un relèvement préalable des effluents.

Les plus courants sont des tamis mobiles articulés (Aquagard) se présentant comme une série de « peignes » montés sur une chaîne en mouvement. Les dents des « peignes » sont constituées d'éléments identiques en plastique, assemblés en

ligne avec un espacement minimum de 1 mm.

Un moteur de 0,75 KW assure l'entraînement de la chaîne mobile et le relevage des refus.

Ce type de filtre est peu sujet au colmatage de par sa conception, mais les dents de peigne ne sont parfois pas suffisamment résistantes.

Le dégraissage

Étant donné la taille actuelle des abattoirs et des débits à traiter qui en résultent, les dégraisseurs statiques ne sont plus adaptés à de tels établissements.

Il faut au moins avoir recours à un dégraisseur aéré raclé.

Cet ouvrage, généralement de forme cylindro-conique en acier ou en béton, remplit à la fois un rôle de dégraisseur et de dessableur.

Les matières denses sédimentent et sont reprises à la base tandis qu'une turbine d'aération immergée produit de fines bulles d'air autour desquelles se rassemblent les graisses, contribuant ainsi à accélérer leur flottation.

La turbine d'aération produit les bulles d'air grâce à une roue alimentée par une prise d'air. Elle est menée par un moteur électrique situé hors eau ou noyé.

Plus les bulles sont finement divisées, meilleure est la qualité du dégraissage et la technique à grosses bulles, qui par les turbulences qu'elle faisait naître, contrariait la séparation des graisses, est maintenant abandonnée.

On s'oriente au contraire vers des systèmes de plus en plus performants, dits systèmes à eau pressurisée, utilisant le principe de la dissolution de l'air sous pression dans l'eau grâce à un compresseur. L'eau pressurisée est ensuite injectée dans le compartiment de flottation où la détente des gaz dissous produit une myriade de micro-bulles d'air optimisant ainsi le phénomène de flottation.

Les dégraisseurs comportent bien sûr des

racleurs entraînés par un moteur pour pousser la couche graisseuse qui se forme en surface vers un plan incliné ainsi qu'une goulotte alimentant une benne ou une fosse de stockage.

Les dégraisseurs aérés cylindro-coniques doivent respecter certaines caractéristiques dimensionnelles qui sont un gage d'efficacité : temps de séjour d'une trentaine de minutes, vitesse ascensionnelle de 5 m/h environ...

Certains abattoirs de volailles de grande taille vont même plus loin dans le prétraitement de leurs effluents en les soumettant à un traitement physico-chimique dans les flotteurs à eau pressurisée. Cela consiste à leur ajouter des corps chimiques (sels de fer ou d'aluminium, polymères organiques) qui manifestent la propriété de faire s'agréger les particules en suspension dans l'eau, puis à faire flotter et à récupérer ces agrégats. Ceux-ci sont riches en graisses et en protéines : aussi ces abattoirs de volailles leur font-ils subir une cuisson déshydratation pour les réincorporer ensuite dans les farines pour alimentation animale.

Ces traitements physico-chimiques permettent d'éliminer 60 à 70 pour cent de la pollution des eaux usées d'abattoir, et ce de façon assez spectaculaire, car les boues décantent généralement très bien et donnent un aspect limpide aux eaux traitées.

Ces installations ne se généralisent cependant pas, car lorsque les installations de cuisson déshydratation n'existent pas, il faut faire face au délicat problème de l'évacuation de très importantes quantités de boues fermentescibles.

Des dégraisseurs ou des flotteurs sont parfois installés à la sortie de certains ateliers particuliers pour traiter spécifiquement leurs rejets (boyanderie). Ces initiatives correspondent à un souci d'augmenter la quantité et la qualité des graisses récupérées (et de mieux les valoriser).

Signalons, à ce propos, que les eaux chaudes rejetées, justement produites par ces mêmes

Food Processing

boyauderies, viennent parfois contrarier les performances du dégraissage.

Conclusion

La lutte contre la pollution dans les abattoirs fait donc appel à toute une série de mesures depuis les aménagements internes qui visent à éviter le contact du sang et des matières stercoraires ou fécales avec l'eau jusqu'aux installations de prétraitement qui permettent de récupérer les matières solides et les graisses des effluents, soulageant ainsi d'autant la station d'épuration biologique finale où la pollution ne peut plus être éliminée que par biodégradation.

L'efficacité de ces mesures et la bonne gestion des moyens mis en place passent bien sûr par le suivi de la qualité et de la quantité des effluents prétraités. Aussi les abattoirs s'équipent-ils maintenant de façon systématique de dispositifs de mesure de débit (canaux de mesure, débitmètre) et de prélèvement (préleveur réfrigéré asservi au débit) et réalisent-ils, avec une périodicité bien définie, l'analyse des paramètres représentatifs de la pollution.

Lexique

DBO₅

« Demande biochimique en oxygène en 5 jours ».

Unité de pollution mesurant la quantité d'oxygène nécessaire à la dégradation par les micro-organismes des eaux résiduaires.

Échaudage des porcs

Opération consistant à faire passer les porcs après saignée dans un bassin d'eau chaude pour faciliter l'enlèvement des soies.

Équarrissage

Atelier de traitement de sous-produits animaux en vue de la fabrication de farine de viande.

Équivalent-habitant

Unité de pollution prenant comme référence la pollution déversée journalièrement par un habitant (exprimée par exemple en : DBO₅ = 54 g/jour).

Floculation

Agglomération des matières colloïdales contenues dans une eau

usée pour former des flocons de taille plus importante permettant leur séparation ultérieure.

Flottation

Séparation des particules de l'eau résiduaire par l'action de micro-bulles d'air formant un ensemble « particules - air » moins dense que l'air qui remonte à la surface de l'ouvrage.

Matières organiques

Matières caractéristiques des organismes vivants. Elles sont en grande partie dégradables par les micro-organismes.

Matières stercoraires

Aliments prédigérés ou digérés se trouvant dans l'animal, principalement dans sa panse.

M.E.S.

« Matières en suspension ». Unité de pollution permettant de connaître la quantité de matières non dissoutes, organiques ou minérales.

Plasma-Cruor

La séparation du sang après centrifugation donne le plasma et le cruor.

Le plasma : albumine, globuline, fibrinogène. Il est incolore.

Le cruor : plaquettes, globules blancs, globules rouges. Il est coloré.

Pompe péristaltique

Pompe fonctionnant par l'écrasement d'un tuyau souple.

Prétraitement

Dispositifs qui arrêtent les éléments facilement éliminables des eaux usées par des moyens physiques en vue de les préparer pour un traitement ultérieur.

Sérum

Plasma défibriné par brassage préalable du sang entier.

Stabulation

Séjour des animaux en étable.

The food processing industry and the environment in Africa

S.G. Kionga-Kamau, UNEP Regional Office for Africa, United Nations Avenue, Gigiri, P.O. Box 30552, Nairobi, Kenya

With a surface area of about 30 million square kilometres, the African continent is the second largest after Asia. It is also the least industrialized, with agriculture constituting the main economic activity for the majority of its peoples. Agriculture itself is not, by and large, heavily mechanized and the national food distribution networks are neither wholly centralized in each country nor modernized or rationalized at their operational levels. The need to reform practices and methods of food production so that production is increased to a level of self-sufficiency is now widely recognized.

Table 1 summarizes the region's commercialized annual output of major agricultural crops for the 1991 year. The significant process industries based on these agricultural raw materials include grain milling factories, meat factories, canneries, sugar factories, coffee factories and breweries.

The food processing industry generally demands a high thermal or mechanical energy input. Mechanical energy constitutes the main process input in grain mills, but there are air pollutants and noise pollution. Dehusking of dried coffee beans is another process operation which presents serious air pollution problems in the work environment. In sugar mills large quantities of surplus bagasse are produced, creating a work environment in which workers can contract bagassosis. In other words, food processing industries like sugar mills, breweries, fruit, vegetable and other canneries, etc. produce large quantities of solid wastes which, if not treated or utilized (e.g. as cattle feed in the case of brewers' grains), give rise to serious disposal problems.

The main threat to the environment, however, is from the liquid effluents of the food processing industry. Discharge of untreated wastewater into watercourses may lead to a serious threat to fish and other

Table 1
Major agricultural crop output for 1991 in Africa¹

Crop	No. of countries growing crop significantly (out of 54 total)	Total production for 1991 in '000 tonnes
Wheat	12	15,800
Maize	41	33,100
Cassava	32	68,800
Bananas & plantains	30	24,800
Groundnuts	30	4700
Tomatoes	16	5000
Pineapples	10	1000
Sugarcane	36	75,600
Coffee (beans)	14	1000
Beer ('000 hectolitres)	19	33,500
Beef & veal	38	4700
Cow's milk & products	38	15,700

aquatic life forms. Liquid milk processing and cheese plants produce wastes, particularly whey, with biochemical oxygen demand (BOD) as high as 3000 mg/litre; the liquid effluents from a brewery's steeping and brewing processes are reported to have BOD of up to 2500 mg/litre; and liquid effluents from sugar processing plants can have a BOD of up to 2000 mg/litre.

Wastewater from other food processing plants such as fruit and vegetable canneries, slaughter houses and meat processing factories, fisheries, etc. have similarly high levels of BOD and suspended solids. Even green coffee berry processing produces liquid effluents which have resulted in pollution of the streams and rivers into which the wastewater is discharged.

It is clear from the foregoing that the food processing industry has substantial potential to generate environmental pollutants. In addition, some freezing operations in the industry utilize ozone-depleting substances.

According to a publication by the Economic Commission for Africa (ECA),² in developing strategies for implementation of the programme for the Second Industrial Development Decade for Africa (IDDA II) within the context of Agenda 21, and to quote from paragraph 163 of the document: "Industry is still unregulated in most African countries because appropriate health and environmental standards are not introduced."

References

1. Table based on statistics from *Africa South of the Sahara* 1994, 23rd ed., and *The Middle East and North Africa* 1994, 40th ed., published by Europa Publications Ltd., London (1994).
2. Rao, M.N. and Datta A.K. (1979) *Waste Water Treatment*. Mohan Pramlani, Oxford, and IBH Pub. Co.
3. Economic Commission for Africa's publication doc. ref. N° E/ECA/CM. 19/8, p. 41.

Aplicación de las tecnologías limpias en la industria láctea

Ricardo F. Luna, Nestlé Argentina S.A., C. Pellegrini 887-(1009) Buenos Aires, Argentina

Resumen

La industria alimenticia en general (como el resto de la industria), se preocupa por la protección del medio ambiente debido a que es el elemento indispensable para la recolección, cultivo y transformación de materias primas en productos elaborados agradables y seguros para el consumo humano. Por lo tanto, el medio que rodea a estas producciones agrícolas incide de forma directa en la calidad final de estos productos. Por esto es necesario implementar una Gestión Integral de la Preservación del Medio Ambiente, comenzando por una política definida por la Dirección para integrar y comprometer a todos los sectores y empleados en los estudios y aplicaciones de tales directivas. Dicha política comprendería los tratamientos de residuos, reciclado y adecuación de los embalajes utilizados para la protección de alimentos, alternativas energéticas, etc. Otros elementos integrantes de la gestión son los procesos de fabricación, la limpieza y la desinfección en instalaciones y equipos, cuyo tratamiento adecuado y racional contribuye al ahorro de energía, y a la reducción de: costos laborales, emisión de residuos y compuestos químicos, desgaste de equipos, y desechos de embalajes.

Abstract

Protection of the environment is one of the concerns of the food and agricultural industry (and the industrial sector as a whole) since this is one of the essential elements in growing, harvesting and transforming raw materials in order to obtain good quality finished products which are fit for consumption. Thus the end quality of these products directly depends on the natural environment in agricultural production. Therefore it is important to set up a global environmental protection management system, the first step of which is the definition of a policy aimed at integrating and involving all sectors and employees in studying and applying directives on this subject. This policy includes waste treatment, recycling and adapting packaging used to protect food products, and diversifying energy sources. Other elements in environmental management are manufacturing processes and, in particular, cleaning and disinfecting installations and equipment. Rational and adequate implementation of these operations enables energy resources to be preserved while at the same time reducing wage costs, waste production, use of chemical products, and wear on equipment and packaging waste.

Résumé

La protection de l'environnement fait partie des préoccupations de l'industrie agro-alimentaire (et de l'ensemble du secteur industriel) car il s'agit d'un élément indispensable dans le processus de culture, de récolte et de transformation des matières premières afin d'obtenir des produits finis de bonne qualité et sains pour le consommateur. Ainsi, la qualité finale de ces produits dépend directement du milieu naturel ambiant des productions agricoles. Il est donc nécessaire de mettre en oeuvre une gestion globale de la protection de l'environnement dont la première étape consiste à définir une politique visant à intégrer et engager l'ensemble des secteurs et des employés dans l'étude et l'application des directives en la matière. Cette politique inclut notamment le traitement des déchets, le recyclage et l'adaptation des emballages utilisés pour la protection des aliments ainsi qu'une diversification des sources d'énergie. Autre élément de la gestion de l'environnement : les procédés de fabrication et plus particulièrement le nettoyage et la désinfection des installations et équipements. Une mise en oeuvre adéquate et rationnelle de ces opérations permet de préserver les ressources énergétiques tout en réduisant les charges salariales, la production de déchets, l'utilisation de produits chimiques ainsi que l'usure des équipements et les résidus d'emballages.

Introducción

Uno de los grandes desafíos del hombre en este último siglo es resolver el problema del crecimiento demográfico y la sustentación del mismo, con una cantidad suficiente de energía y alimentos para el abastecimiento. Dado que las fuentes necesarias para satisfacer estos requisitos son limitadas, la búsqueda de un uso racional del aprovisionamiento energético y de materias primas es motivo de preocupación en la industria ya que, los daños en el medio ambiente no

sólo representan problemas puntuales, sino que en la mayoría de los casos deben ser tratados en términos de "globalización", al igual que el estudio de mercados. La industria alimenticia utiliza productos agrícolas, por lo tanto, es una de las principales afectadas por cualquier daño o modificación en el medio ambiente, debido a que tanto los animales como los vegetales traducen estas alteraciones en:

- ♦ menor rendimiento de producción
- ♦ modificaciones organolépticas

- ♦ incorporación de contaminantes en toda la cadena
- ♦ mayores costos en los productos por la necesidad de análisis y controles de estos últimos
- ♦ pérdidas económicas en procesadores y agricultores.

La reacción inmediata ante este hecho, fue un estudio de la situación para poder evitar y disminuir los problemas antes mencionados y colaborar en su solución verificando a su vez, en qué medida contribuye la propia actividad de la industria alimenticia a la generación de residuos y desperdicios, y ampliando el concepto tradicional de mejora mediante piletas de tratamientos.

Para ello, básicamente, algunas empresas han desarrollado diferentes programas y proyectos de estudio de impacto ambiental, eliminación de residuos, uso racional y reciclado del material de embalaje, selección de proveedores que cumplan con estas premisas, divulgación e interrelación con organismos oficiales y ONGs, etc.

La etapa inicial de esta labor, tal como se requiere en los sistemas de las Normas Series ISO 9000 e ISO 14000, es la definición de la política de aplicación en toda la empresa, en la cual se especifican el compromiso de respeto por el medio ambiente de la Alta Dirección y la seguridad de que el conjunto de operaciones y los empleados cumplan con dichos principios.

Por último, se deben llevar registros de las actividades propuestas, controles y verificaciones de resultados con auditorías internas.

Limpieza y Desinfección - Un ejemplo de acción

Los procesos productivos actuales contemplan el uso de la automatización de las líneas para un mejor aprovechamiento energético de las distintas operaciones (tratamientos térmicos, mezclado, envasado, mantenimiento y limpieza de instalaciones y equipos) necesarias para la manufactura de alimentos. En el presente trabajo, sólo abordaremos una de ellas: la limpieza y desinfección de equipos e instalaciones, para poder destacar cómo ciertas acciones simples pueden contribuir a una mejor gestión de recursos y una menor emisión de residuos.

Existen tres razones fundamentales por las cuales son necesarias las tareas de limpieza:

- ♦ Eliminación de residuos alimenticios y microorganismos.
- ♦ Mantenimiento y cuidado de las instalaciones.
- ♦ Estética y orden.

Las metodologías utilizadas para este fin son la

Food Processing

limpieza en húmedo (en sus diferentes variantes) y la limpieza en seco (cuyo uso posee limitaciones y es de escasa difusión). Existen diversas publicaciones y Códigos de Práctica con las recomendaciones para el uso adecuado de estas metodologías, algunas de las cuales resumiremos.

Limpieza en húmedo: Se divide en los sistemas de aplicación por circuitos cerrados (CIP) y aquellos que necesitan una labor manual (sistemas abiertos). La elección de cada uno de ellos es acorde al lugar y equipamiento utilizado.

Siempre que sea posible, es recomendable la adopción de los sistemas CIP, ya que permiten la recirculación y reutilización de soluciones desinfectantes y aguas de enjuague en algunos casos.

El éxito de esta labor viene determinado por:

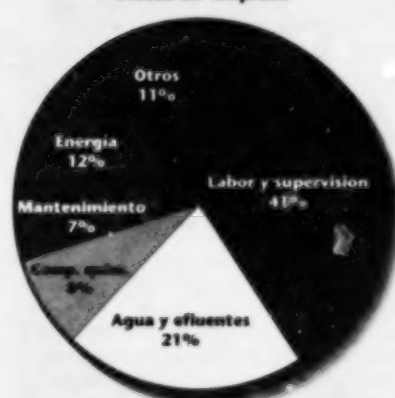
- ♦ El estudio de la selección de los agentes de limpieza adecuados (generalmente ácidos y álcalis).
- ♦ La concentración efectiva.
- ♦ La temperatura de aplicación.
- ♦ El tiempo de contacto.
- ♦ El caudal necesario para alcanzar todos los puntos del equipo con una adecuada remoción de residuos.

Los sistemas de limpieza manual o abiertos necesitan una selección más rigurosa de los compuestos químicos a utilizar (compuestos halogenados, QACs, ácidos aniónicos, etc.) y el empleo de las condiciones mencionadas en la limpieza CIP.

De acuerdo con un estudio efectuado por una de las principales firmas (**Gráfico 1**), cada una de estas operaciones representan diferentes costos en los trabajos de limpieza.

Mediante una lectura simple del gráfico se observa que contrariamente a lo que se pudiera pensar, los costos de limpieza no vienen determinados por el uso de agentes químicos, sino por los costos laborales (41 %) y el uso de agua, energía y efluentes (33 %). Para poder tener un control exhaustivo sobre estas operaciones es

Gráfico 1
Costos de limpieza



Fuente: OVERSEY S.A.

necesario implementar un detallado sistema de auditoría que compruebe algunos de los siguientes elementos:

- ♦ Procedimientos escritos de las labores de limpieza.
- ♦ Entrenamiento previo del personal encargado, poniendo especial énfasis en los daños que puede ocasionar una mala labor (tanto al consumidor como al medio ambiente).
- ♦ Inspecciones visuales, físico-químicas y microbiológicas para verificar la efectividad del proceso.
- ♦ Registros y revisión de tareas por personal jerárquico.
- ♦ Estudio de efluentes generados y flora contaminante normal.

Cada uno de los puntos enunciados tiene su particular importancia y deben ser acompañados de otras medidas adicionales, entre las cuales debemos destacar la separación en zonas y distribución de los procesos para reducir las posibilidades de contaminación y necesidades de limpieza. Otro factor de importancia es el de los recursos humanos, que como hemos podido

observar, representan un alto porcentaje del costo de la operación.

El personal involucrado debe tener un tiempo de permanencia en el sector para poder conocer en detalles las maquinarias e instalaciones, contar con el estímulo de superiores y comunicación inmediata de cualquier anomalía. Una mala selección y remuneración del personal de limpieza incrementa los daños y costos mencionados, los cuales forman parte de los famosos costos ocultos o de "no calidad".

Limpieza en seco: Este procedimiento es uno de los más indicados para efectuar las labores de limpieza de productos deshidratados o con un bajo contenido de agua (cereales y leches en polvo, extrudados, chocolates, etc.). No obstante, la reducción del agua en todas las áreas productivas es un buen sistema barrera para evitar la proliferación de microorganismos.

Las principales ventajas del sistema son:

- ♦ La eliminación de agentes químicos
 - Reducción de costos
 - Eliminación de riesgos en la preparación
 - Evaluación del agente según el microorganismo
 - Reducción de envases
- ♦ La mejora de la calidad de los efluentes
- ♦ La reducción de los niveles de contaminación microbiana en líneas y entornos
- ♦ La reducción de la corrosión y daños de máquinas y estructuras
- ♦ El menor requerimiento energético, etc.

El fundamento de este sistema consiste simplemente en evitar la diseminación de polvo por uso de aire comprimido o barridos innecesarios, eliminar el polvo contaminado por sistemas seguros de aspiración y evitar el ingreso de aire externo en los distintos locales con cargas indeseables de microorganismos.

Basándose en todo lo expuesto, consideramos necesario incluir dentro de los procesos de "mejora continua" todas aquellas actividades que en mayor o menor grado puedan contribuir a mejorar la protección del medio ambiente. ♦

Nepal: rapid industrialization with minimum environmental damage

R.B. Shrestha, Founder, PUJA, INC., The Nepal Resource and Information Center, 1050 Connecticut Ave. NW, P.O. Box 65037, Washington, D.C. 20036, USA

Abstract

Achieving rapid industrialization with minimum environmental damage, as envisioned by Nepal's Environmental Protection Council, requires a practical framework for implementation, as well as an appropriate institutional structure readily available to agencies responsible for the enforcement of environmental regulations. Industry-related guidelines already experimented with and enforced in industrialized countries, particularly the United States, are the conceptual model for the implementation framework described in this article.

Résumé

Conduire une industrialisation rapide tout en préservant l'environnement, comme l'envisage l'Environmental Protection Council du Népal, présuppose que les organismes chargés de l'application de la réglementation en matière d'environnement disposent d'un cadre d'implémentation pratique ainsi que d'une structure institutionnelle adaptée. Les règles de conduite applicables au secteur industriel testées et déjà en vigueur dans certains pays industrialisés, et en particulier aux États-Unis, constituent le modèle conceptuel du cadre d'implémentation décrit dans cet article.

Resumen

Alcanzar una rápida industrialización con el mínimo daño medioambiental posible, como propugna el Consejo para la Protección Medioambiental de Nepal, requiere aplicar un marco de trabajo práctico, además de una estructura institucional apropiada a disposición de las agencias responsables de la aplicación de las regulaciones. El modelo conceptual para el marco de implementación descrito en este artículo son las pautas relativas a la industria ya experimentadas y aplicadas en los países industrializados, en particular en Estados Unidos.

Introduction

In Nepal, the pollution of the Bagmati and Vishnumati Rivers, excessive suspended particulate matter in the atmosphere of the Kathmandu Valley (World Bank, 1991), and the waste management problems of the Balaju Industrial District (IUCN, 1992), to name a few, exemplify the environmental impacts of industrial development and uncontrolled urbanization taking place.

But these impacts are not unpreventable, nor are they unremediable. Pittsburgh, a major industrial city and the environmental nightmare of the 1950s, for instance, is now one of the cleanest and most liveable cities in the United States (Businessweek, 1988). The key is the formulation of sound industrial planning and the strategic enforcement of environmental laws, with appreciable, tangible results.

With well-defined environmental regulations and a practical implementation framework, plus a suitable institutional set-up to go with it, rapid industrialization with minimum environmental impairment, as envisioned by the Environmental Protection Council of His Majesty's Government of Nepal (EPC, August 1993), can eventually be a reality.

Identification of current problems Crisis in perception

In Nepal, due to the relative newness of the subject matter, environmental pollution issues have long been perceived to be synonymous with the country's deforestation and soil erosion problems. The incorporation of environmental matters with forestry to create the Department of Forestry and Environment (DFE) in 1991 illustrates the continuity of this misperception. The interrelationship between industry and the environment is yet to be fully realized by policy-makers and the general public. Due to such perceptual deficiencies, the nature and extent of environmental problems have continued to be misunderstood. This has, in effect, undermined the efforts of government agencies to prioritize environmental problems and identify the appropriate methods to solve them.

Now, with the establishment of the Environmental Protection Council within the National Planning Commission (NPC) and the integration of environment with the functioning of various government ministries, particularly the Ministry of Industry and the Ministry of Housing and Physical Planning (MHPP), it is expected that the multi-dimensional characteristics of

environmental issues will be realized and understood to a greater extent.

Data gap

The majority of the reports written on the environmental issues of Nepal are basically compilations of information already in existence and lengthy descriptions of problems that have already been identified. These reports usually do not include the possible mitigatory measures and suitable implementation mechanisms to solve the problems described. Such reports only help memorialize the problems. This could be one of the reasons most of the reports remain just "reports for collection", or reports to be left in the file cabinet to age into historic documents.

The identification of solutions, and of the strategies to enforce them, are some of the important factors that determine the utility and relevance of a report for the prescribed purposes. The emphasis on the development of an implementation framework in the present exercise underlines the shortage and need of solution-oriented road maps, rather than prevailing problem-oriented reports.

Lack of an information network

There is a lack of concrete access to information on the experience of other countries with industry and environment. The lack of information on environmental alternatives being implemented for industrial pursuits by developed countries presents a serious constraint to policy-makers, with respect to the identification and selection of industries and applicable technologies that are relevant to, and compatible with, the country's environmental policy goals. In addition, there is at present no systematic effort to gather and evaluate Nepal's own experience with industrial pursuits and performance, or the means to make the existing industrial database accessible to the industrial community, such as the Federation of Nepalese Chambers of Commerce and Industry (FNCCI) and/or interested parties.

Strengthening of the existing database support system at the MOI (Nepal Industrial Data System) with information on environment and technology offers a viable option for the mitigation of such lacunae.

Delineation of priorities

This exercise focuses on outlining the implementation framework, rather than on the for-

Other topics

Table 1
An implementation framework for the establishment of "green" industry in the Kingdom of Nepal

PHASE	ENVIRONMENTAL ACTION	APPLICABLE & APPROPRIATE REGULATIONS / GUIDELINES	GUIDING COMMITTEE (Consisting of)
I. PRE-OPERATION	Project Formulation	• Focus on environmentally correct approach • Assessment of environment impacts (according to EPC specification) • Cost-benefit analysis/preparation of EIS (according to NPC guideline) • Preparation of Pollution Abatement Plan • Preparation of Emergency Contingency Plan • Preparation of Environmental Education Plan	• Environment Protection Council (EPC) • National Planning Commission (NPC) • Ministry of Health (MOH) • Ministry of Interior (MOI) • Royal Nepal Academy of Science & Technology (RONAST)
	License/Permit	• EIS Report (reviewed by EPC-approved independent experts) (15 days) • Submission of Pollution Abatement Plan (by industry) • Submission of Contingency Plan for Emergency (by industry) • Filing of "Community right-to-know" list with public library (e.g. University Library, Keshar Library) by industry • Public comment period (15 days) • Provision for environmental education/training (through Ministry of Education) • Permit from MOTC	• EPA Directives (USA) • Ministry of Trade & Commerce (MOTC) • Ministry of Industry (MOI) • Nepal Chamber of Commerce (NCC)
	Finance (Bank loan)	• License/permit documents • Environmental auditing (by independent experts) (45 days) • Evidence of "maximum economic benefit with minimum environmental cost" • Letter of recommendation from NBA • Letter of consent from EPC • Loan approval	• Lender Liability (USA) • RCRA, 42 U.S.C. sec. 6928 (1988) • CERCLA 42 U.S.C. sec. 6907 (1988) • Ministry of Industry (MOI) • Ministry of Finance (MOF) • Nepal Rastra Bank (NRB) • National Industrial Development Corporation (NIDC) • Nepal Bankers' Association (NBA)
II. OPERATION	Raw Material Acquisition	• Use of environmentally benign technology/equipment • Selection of least toxic, non-carcinogenic, solvent-based (preferably water-based) materials	• Trade Policy, 1992 (HMG) • 40 C.F.R. Part 190-399 (EPA/USA) • Department of Health (DOH) • Department of Commerce (DOC) • Department of Supply (DOS) • Nepal Foreign Trade Association (NFTA)
	Production/Processing	• Emission control • Spill prevention	• Clean Air Act, 1990 (EPA/USA/Europe) • National Contingency Plan (EPA/USA) • Department of Health (DOH) • Environment Protection Council (EPC)
	Product packaging	• Use of packaging materials made of biodegradable or recyclable substances	• EPA Directives/Guidelines (USA) • Department of Industry (DOI) • Department of Supply (DOS) • City Councils (Municipalities)
	Shipment	• Permit from DOT	• DOT Manifest • Department of Transportation (DOT) • Department of Health (DOH)
III. POST-OPERATION (short-term)	Waste handling practices	• Separation of waste streams • Effluent collection/drumming • Recycling (on-site) • Waste treatment (on-site) • Waste reduction (on-site)	• Hazardous Waste Management (Japan/Recycling) • Solid Waste Management (Canada/Europe) • Resource Conservation & Recovery Act (RCRA), 1976 (USA) • Superfund Amendment & Reauthorization Act (SARA), 1986 (USA) • Department of Health (DOH) • City Councils (Municipalities)
	Waste disposal/destruction	• Incineration/thermal destruction or best available and affordable technology	• Best Available Technology (BAT) (USA/Japan) • National Pollutant Discharge Elimination System (NPDES) • Publicly Owned Treatment Works (POTW) (USA) • Safe Drinking Water Act, 1965 (EPA/USA) • Water Quality Criteria, 1986 (EPA/USA) • Groundwater Protection Act, 1989 (EPA/USA) • NIDC • Water and Energy Commissions (WECS) • City Councils • RONAST
	Off-site (Priority 2)	• Effluent discharge to POTW after pre-treatment	
POST-OPERATION (long-term)	Monitoring/inspection	• Periodic effluent sampling and annual plant inspection (by Dept. of Health Official)	• EPA Directives (USA) • Environment Protection Council • Ministry of Health

mulation of environmental regulations. The reasons are as follows.

First of all, modern industrialization is not a new phenomenon that originated in Nepal. It is new here because Nepal started its development process rather late. Historically speaking, it began as early as the 16th century in the western world, primarily in what is now the united Europe or the European Community. Since then numerous laws, acts and directives have been proposed, developed and enforced with considerable success in many parts of the world. The

regulations are already there for Nepal to choose from (see, for example, UNEP, 1992). What Nepal needs to do now is focus on reinterpreting the available laws, national or international, in a Nepalese perspective and enforce them strategically according to local specifics and needs. In view of the present context of developmental urgency and marginal resources, Nepal does not have time nor can it afford to become engaged in the proverbial "reinvention of the wheel".

Second, a majority of the government institutions of His Majesty's Government are seeking

specific enforcement strategies to implement the national plans designed and developed for them by the National Planning Commission Secretariat, a policy-making body of HMG. Absence of implementation strategies in overall operational procedures is being recognized as one of the causes of ineffectiveness in the functioning of government institutions. The importance of the implementation aspect is therefore obvious.

Third, proper utilization of the knowledge and experience of the industrialized countries in the implementation of environmental regula-

tions is one of the efficient and economical means of building an industrial system in Nepal that is environmentally sound, sustainable, and suitable to its own socio-cultural demands and economic needs. Furthermore, it helps prevent the repetition of the blunders of developed nations in the process of industrialization.

Implementation framework

The implementation framework outlined in Table 1 is an attempt to provide an option to HMG, particularly the Ministry of Industry, for strategies to address the country's need for an effective means to make industrial development more compatible with its environmental concerns. This framework is also an attempt to provide a baseline for the implementing agencies in Nepal to help enforce the environmental regulations currently being developed by HMG. It consists of three components, which correspond to three conventional phases of a typical industrial project:

- ◆ Pre-operation (Project Formulation and Planning);
- ◆ Operation (Project Implementation); and
- ◆ Post-operation (Waste Management and Disposal).

Each component includes a set of environmental actions, and the applicable foreign as well as domestic regulations. Various representative government agencies, as well as non-government institutions, who can play an instrumental role in assisting new industries to undertake specific environmental actions and thus comply with the identified regulations, constitute the guiding committee of the respective component.

A strength of this framework is the inclusion of the implementation strategies and regulations that enjoy public acceptance and have proven records of success in the country where they have been implemented. The Community Right to Know Act, or Title III of the Superfund Amendment and Reauthorization Act (SARA), 1986, for example, has proven very effective in enforcing scores of environmental laws and materializing public participation in pollution control activities in the United States. Given the commonality in the basic nature of the problems that are inherent in the process of industrialization, enforcement of similar actions after necessary modification according to a country's socio-economic priority should not be a difficult task. The success or failure of our effort, of course, depends on our seriousness in observing the procedures laid out by the framework.

The industry-related guidelines already experimented with and enforced, with results of proven efficacy, in the industrialized countries, particularly the United States, serve as the conceptual model for this framework.

Institutional arrangement

In order for government authorities to enforce this implementation framework, a well-organized institutional structure capable of guiding, coordinating and monitoring the activities of industries to maintain a certain level of regula-

tory compliance would be necessary.

The institutional arrangement presented in Table 2 constitutes such a structure. Various government entities representing different aspects of industrial functions are categorized into a specific group or committee corresponding to the three phases – pre-operation, operation and post-operation – of the industrialization process. It is designed to simplify and expedite the processing of paperwork and exchange of information among pertinent departments of government, so that the department concerned can reach a decision with greater efficiency and speed. This in turn will enhance the promotion of industrial growth in Nepal. The present state of stagnation and prolongation in the industrial licensing and project appraisal process can therefore be significantly reduced.

The basic strength of this new arrangement is its features: minimal paperwork, public participation in every step, and transparency in the overall activities of government agencies from proposal appraisal and licensing to project approval and project implementation.

Enforcement strategies

Strategy 1 – Application of economic instruments:

Since the inception of environmental policy in most developed nations, the command-and-control approach has been the predominant strategy (Bernstein, 1993). This involves direct regulation, along with monitoring and enforcement systems, and relies primarily on applications of regulatory instruments such as standards, permits and licenses, as well as land and water use controls. The command-and-control approach affords the regulator a reasonable degree of predictability about the extent to which pollution levels will be reduced.

However, this approach has proven to be economically inefficient and difficult to enforce, particularly in countries where a non-performing bureaucracy and regulatory non-compliance are still facts of life.

In view of those difficulties, many countries have begun to adopt economic instruments to introduce more flexibility, efficiency and cost-effectiveness into pollution control measures. The economic instruments utilized in developed countries, particularly in the United States, are:

- ◆ pollution charges (e.g. disposal charges, user's fees);
- ◆ market creation (e.g. subsidies, tax differentiation);
- ◆ deposit-refund system (e.g. recycling compensation); and
- ◆ enforcement incentives (e.g. non-compliance fees).

These instruments act as incentives to polluters to choose their own means of pollution control. When properly implemented, economic instruments have several advantages over regulatory instruments. They stimulate the development of pollution control technology and expertise in the private sector, eliminate a

government's requirement for large amounts of detailed information to determine the most feasible and appropriate level of control for each plant or product, and above all provide the government with a source of revenue to support pollution control programmes. In addition, economic instruments have the capacity to regulate pollution according to market mechanisms and thus facilitate deregulation and a reduction in government involvement.

Strategy 2 – Inclusion of socio-cultural factors in an industrial planning and enforcement scheme:

Philosophically speaking, the popularity or success of a system in a country, whether it is political, legal or even industrial for that matter, is traditionally determined by the extent to which the socio-cultural values and economic priorities of its citizens are taken into account. Keeping this in developmental perspective, it is advisable to design the enforcement scheme according to local beliefs and priorities. In sum, industrial growth along with environmental protection should serve the local values.

Strategy 3 – Accountability of implementing agencies:

The enforcing agencies should be made responsible for the success or failure of the government's environmental policies. The score cards on each implementing agency should be made available to the public upon request, on an annual basis. The Nepal Forum for Environmental Journalists (NFEJ) and/or similar non-governmental organizations (NGOs) could keep track of the duties and performance of the enforcing agencies for the purpose of general information. The theme here is: authority must always be accountable.

Strategy 4 – Industry for the people, by the people:

Popular consensus, and participation in policy formulation and decision-making, will only help enforce regulatory provisions. Therefore, the appropriate political message of the current developmental campaign should be: "Industry – for the people, by the people".

Strategy 5 – Environment for industry:

Environmental preservation is necessary; so is industrialization. Environmental issues should not be the factors inhibiting industrial growth. Rather, environmental concerns should provide a sense of duty among the industrialists to seek a balance between industry and environment. The promotion of a waste management programme itself as a profit-making industry would provide impetus for industrialists to become environmentalists as well, and thereby perceive environmental problems as industrial opportunities. FNCCI can play a significant role in this prospective.

Strategy 6 – Industry for environment:

The key here is the selection of environmentally sound technologies, with an emphasis on the

Other topics

Table 2
Institutional arrangement

I. PRE-OPERATION PHASE (PROJECT DEVELOPMENT):

GUIDING COMMITTEE 1 (POLICY/GUIDELINES):

REPRESENTED BY		RESPONSIBLE AGENCY
• Environment Protection Council (EPC)	(Policy-making)	
• National Planning Commission (NPC)	(Planning)	
• Ministry of Health (MOH)	(Public health interest)	
• Ministry of Interior (MOInt)	(Implementation/law enforcement)	
• Royal Nepal Academy of Science & Technology (RONAST)	(Technology selection)	
• Ministry of Industry (MOI)	(Industrial feasibility)	
• Ministry of Education (MOE)	(Education/training)	
FUNCTION		
• Develop national policies and regulatory guidelines for establishment of environmentally benign industry		(EPC)
• Develop guideline for pollution prevention or abatement and control plan		(NPC)
• Develop guideline for Emergency Contingency Plan		(NPC)
• Develop protocol for regular sampling and annual plant inspection		(MOH)

GUIDING COMMITTEE 2 (ELIGIBILITY ASSESSMENT):

REPRESENTED BY		
• Ministry of Industry (MOI)	(Proposal assessment)	
• Ministry of Education (MOE)	(Training/public records)	
• Nepal Chamber of Commerce (NCC)	(Interest of industrial group)	
• Ministry of Trade and Commerce (MOTC)	(Proposal approval)	
FUNCTION		
• Have Environmental Impact Assessment (EIA) Report of the Industry Group reviewed by EPC-approved independent experts		(MOI)
• Assess feasibility of pollution prevention plan and emergency contingency plan		(MOI)
• Assess cost-benefit analysis prepared and submitted by industry group		(MOTC)
• Assess Environmental Education Plan, gather public comments, and maintain "community right-to-know" type records		(MOE)
• Permit granting		(MOTC)

GUIDING COMMITTEE 3 (FINANCE):

REPRESENTED BY		
• Ministry of Finance (MOF)	(Economic analysis)	
• Ministry of Industry (MOI)	(Financial statement)	
• National Industrial Development Corporation (NIDC)	(Consistency with NEC/NPC)	
• Nepal Rastra Bank (NRB)	(Fund availability)	
• Nepal Bankers' Association (NBA)	(Interest of bankers)	
FUNCTION		
• Fund appropriation		(MOF)
• Final assessment of economic benefit vs. environmental cost		(MOI)
• Assess consistency with EPC/NPC guidelines		(NIDC)
• Assess availability of fund		(NRB)

II. OPERATION PHASE (IMPLEMENTATION):

GUIDING COMMITTEE 1 (PREPARATION): RESPONSIBLE AGENCY

REPRESENTED BY		
• Department of Health (DOH)	(Implementation of health regulation)	
• Department of Commerce (DOC)	(Implementation of trade policy)	
• Department of Supply (DOS)	(Import monitoring)	
• District/City Office (DCO)	(Law enforcement)	
• Foreign Trade Association (FTA)	(Interest of industry group)	
FUNCTION		
• Selection of less harmful materials		(DOH)
• Recommendation on locally manufactured materials		(DOS)
• Observation of EPC/NPC Guidelines		(DOC)
• Enforcement of environmental laws and regulations		(DCO)

GUIDING COMMITTEE 2 (MANUFACTURING):

REPRESENTED BY		
• Environmental Protection Council (EPC)	(Emergency planning)	
• Department of Health (DOH)	(Protection of public health)	
• District/City Office (DCO)	(Law enforcement)	
FUNCTION		
• Observation of emission control/environmental standards		(DOH)
• Pollution control, prevention and investigation (in the event of accident)		(EPC)
• Enforcement of law and order		(DCO)

GUIDING COMMITTEE 3 (COMMERCIALIZATION):

REPRESENTED BY		
• Department of Industry (DOI)	(Material guidance)	
• Department of Supply (DOS)	(Import monitoring)	
• District/City Office (DCO)	(Disposal guidance)	
FUNCTION		
• Selection of environmental products for packaging		(DOI)
• Focus on locally manufactured materials		(DOS)

GUIDING COMMITTEE 4 (SHIPMENT):

REPRESENTED BY		
• Department of Transportation (DOT)	(DOT manifest)	
• Department of Health (DOH)	(Public health, safety)	
FUNCTION		
• Maintain record of transportation (manifest) (from factory to store)		(DOT)
• Provision of public health safety		(DOH)

Table 2 (continued)
Institutional arrangement

III. POST-OPERATION (WASTE MANAGEMENT):		
GUIDING COMMITTEE 1 (WASTE TREATMENT, UTILIZATION AND MANAGEMENT)		
REPRESENTED BY	- District/City Council (DCO) - Department of Health (DOH)	(Solid waste management) (Public health)
FUNCTION	- Develop and enforce guidance for waste collection, waste reduction, recycling, and overall waste management - Protect public health and environment	(DCO) (DOH)
GUIDING COMMITTEE 2 (WASTE DESTRUCTION/DISPOSAL):		
REPRESENTED BY	- Royal Nepal Academy of Science and Technology (RONAST) - Water and Energy Commissions (WECS) - District/City Council - Department of Health - National Industrial Development Council (NIDC)	(Technology selection) (Waste discharge) (Solid waste management) (Public health, safety) (Business perspective of waste management)
FUNCTION	- Waste incineration/destruction (solid wastes) - Manage NPDES-type system for discharge of waste effluent (liquid wastes) into environment at the safe level by environmentally benign techniques when waste treatment or destruction is economically and/or technologically infeasible - Operate POTW-type (liquid) waste treatment units - Selection of best available and affordable technology - Commercialization of waste management practices	(DCO) (WEC) (WEC) (RONAST) (NIDC)
GUIDING COMMITTEE 3 (MONITORING/INSPECTION):		
REPRESENTED BY	- Environment Protection Council (EPC) - Ministry of Health (MOH) and environmental - Ministry of Interior (MOInt) - Tribhuvan University (TU)	(Regulatory safeguard) (Protection of health) (Law enforcement) (Research and analysis)
FUNCTION	- Develop and implement sampling protocols, schedules, and standards - Annual facility inspection - Research and analysis - Issuance of notice of violation and investigation - Enforcement of environmental laws	(MOH) (EPC + MOH) (TU) (EPC) (EPC+MOInt)

utilization of environmentally benign materials, and the adaptation of process-specific waste separation and minimization schemes.

Agenda for Action:

- ◆ Develop political commitment and consensus among and between policy-makers and the general public, with a focus on promoting environmentally sound industrial development.
- ◆ Identify and select industrial activities that are compatible with goals of environmental protection set out by government institutions.
- ◆ Localize industrial activities by designating specific sites for industrialization within the framework of zoning programmes. This will help manage industrial development in a more organized way, and thus help bring about a balance in population distribution. Improvement in the existing land-use pattern, with the delineation of industrial zones, offers an option for such purposes.
- ◆ Develop social infrastructure serving the needs of migrant workers (e.g. health care systems, school systems, housing facilities for the labour force, etc.) in and around the area designated for an industrial establishment.
- ◆ Devise mechanisms to build waste management itself into an industry (e.g. recycling facilities, domestic production of pollution control equipment, reclamation or material recovery plants).
- ◆ Mobilize NGOs. In organizational and mana-

gerial terms, NGOs possess a number of advantages over government institutions. Being administratively independent, NGOs have flexibility and adaptability in choosing and implementing appropriate programmes. NGOs have also been more successful in generating meaningful participation of minorities, women and economically disadvantaged groups of people in environmental planning and implementation processes (ESCAP, 1990).

- ◆ Educate people through the mass media (e.g. television) or communication programmes to bring about awareness in the general public regarding the possible adverse impacts of industrial activities on the environment.

- ◆ Develop human resources for environmental and industrial skills. During the last five to ten years many new industries have opened, with plants operating with processes and products new to Nepal. In cases where new technology has been introduced without adequate human resources, there has been heavy reliance on the use of imported skills from India to secure the running of the plants. The lack of technicians and managers with an adequate background in environmental science is most strongly felt in the private sector.

Discussion and remarks

With the exception of some of the industries in and around the Kathmandu Valley, industrial units as such are not the major sources of envi-

ronmental problems in Nepal. At least not yet. The scale of industrialization is still too small, compared with that in developed countries, to make any significant impact on the environment of Nepal. The present support system that has come with the industrial establishments is, however, the problem. Uncontrolled urbanization, population growth, and overexploitation of existing physical facilities by the incoming migrant workers are responsible for the current environmental problems. The lack of enforceable strategies, and the political will, to face these problems at the human level have further exacerbated them.

With the current policy of giving national priority to industrial means for the pursuit of poverty alleviation and rapid economic development (UNIDO, 1992), growth in industrial activities is inevitable. Looking at the experiences of developed countries like the United States and Japan, it becomes obvious that there is a socio-economic benefit in making environmental protection an integral part of policy planning and implementation.

Guiding principles for the pursuance of environmentally compatible industrial policies are offered by factors such as the desire for economic efficiency; compatibility with administrative, political and judicial frameworks, economic conditions, and tax structure; political acceptability of instruments; ease of monitoring and enforcement; consistency with overall environ-

Other topics

mental policy; and compliance with relevant international agreements.

Further efforts towards the development of enforcement strategies to make industrial pursuits environmentally sound and sustainable, as envisaged in this exercise, can be considered a worthwhile endeavour.

Acknowledgements

The author wishes to express sincere thanks to the United Nations Development Programme (UNDP), Kathmandu, for the opportunity to participate in the TOKTEN Consulting Mission with the Ministry of Industry of His Majesty's Government of Nepal.

The author remains grateful to the staffs of the Ministry of Industry, HMG for their cooperation and support in the preparation of the post-mission report.

Note: This article has been excerpted from the 1994 post-mission report presented to the United Nations Development Programme (UNDP) by the author following the completion of his TOKTEN consulting mission in Nepal.

References

- ATAS (spring 1992) *Environmentally Sound Technology for Sustainable Development*, Issue 7. United Nations.
- Bernstein, Janis D. (May 1993) *Alternative Approaches to Pollution Control and Waste Management: Regulatory and Economic Instruments*. UNDP/UNCHS/World Bank, Washington, D.C., pp. 3-5.
- Businessweek* (22 October 1988) Corporate Cities, p. 22.
- 40 C.F.R. Part 190-199 (US EPA), 1992.
- EPA Fact Sheet, 1992 (a) Resource Conservation and Recovery Act (RCRA), 1976. US EPA.
- EPA Fact Sheet, 1992 (b) Superfund Amendment and Reauthorization Act (SARA), 1986. US EPA.
- EPC (August 1993) *Nepal Environmental Policy and Action Plan (NEPAP): Integrating Environment and Development*. HMG.
- ESCAP (1990) "Role of the Media and Non-Governmental Organizations in the Promotion of Public Participation in Environmentally Sound and Sustainable Development", Media Symposium on Communication for Environment, Economic and Social Commission for Asia and Pacific, Bangkok, 10-16 October 1990.
- IUCN/NPC (December 1991) *Sources of Industrial Pollution in Nepal: A National Survey*.
- IUCN/NPC (November 1992) *Balaju Industrial District Pollution Control Study*.
- IUCN/NPC (December 1993) *Legislative and Institutional Framework for Environmental Management in Nepal*.
- MAB/UNESCO (1977) *Guidelines for Field Studies in Environmental Perception*. Technical Note Series N° 5, p. 99.
- MOI (1993) *Industrial Statistics: Manufacturing Industries*. F/Y 2049/2050 (1992/1993). Kathmandu.
- New Era (July 1991) *National Report on United Nations Conference on Environment and Development (UNCED)*. Country: Nepal.
- UNDP (July 1993) *Industrial Pollution Control Management*. NEP/91/029/A/01/99 (Project Document).
- UNEP press release (September 1992) *From Regulation to Industrial Compliance - Building Industrial Capabilities* (UNEP IE Technical Report N° 11).
- UNIDO (1987) *Sustainable Industrialization through Optimal Management of Natural Resources*. US/NEP/87/052/11-01/02/04 (Technical Report).
- UNIDO (March 1992) *Environmental Policies and Industrial Pollution*. DP/NEP/90/020 (Technical Report).
- World Bank (1991) *Bagmati Basin Development Project Report*. Kathmandu. ♦

A note on public policy and innovation in the biomass-based industrial sector: lessons from the sugarcane industry in Brazil and India¹

Pierre Audinet, Centre International de Recherche sur l'Environnement et le Développement (CIRED), 19, rue Amélie, 75007 Paris, France

Abstract

Several developing countries are implementing long-term, biomass-based industrialization policies. Sugarcane refining has come to represent over 1 per cent of GDP in Brazil and India. In the context of low international energy and raw material prices, and scarce investment funds, the viability of biomass-based industry cannot depend on one final product such as ethanol or sugar. There is an urgent need for diversification. Technology diffusion must be improved, and the impact of public policies thoroughly analysed.

Résumé

Plusieurs pays en voie de développement mettent actuellement en oeuvre des politiques d'industrialisation à long terme, fondées sur l'utilisation de la biomasse. Au Brésil et en Inde, le raffinage de la canne à sucre représente d'ores et déjà plus de 1 % du PIB. Dans un contexte mondial caractérisé par la chute des prix des matières premières et énergétiques, et par la faiblesse des investissements, l'avenir de l'activité industrielle basée sur l'utilisation de la biomasse ne saurait dépendre d'un seul produit, tel que l'éthanol ou le sucre. Il est urgent de diversifier les productions. La diffusion des technologies doit se développer, et il convient d'analyser soigneusement l'impact des politiques conduites par les pouvoirs publics.

Resumen

Varios países en vías de desarrollo están poniendo en práctica políticas a largo plazo de industrialización basadas en la biomasa. El refinado del azúcar de caña ha pasado a representar más del 1% del PIB en Brasil e India. En un contexto en el que los precios de la energía y de las materias primas están bajos a nivel internacional, y en el que se produce una escasez de fondos de inversión, la viabilidad de la industria basada en la biomasa no puede depender de un producto final como el etanol o el azúcar. Existe una necesidad imperiosa de diversificación. Se debe mejorar la difusión de la tecnología y analizar cuidadosamente el impacto de las políticas públicas.

Building a national supply capacity: public policy principles

Biomass-based industrial development policies often display a common set of targets to tackle problems of public interest. Policies initially implemented in Brazil and India to promote the use of sugarcane as a raw material for the industrial production of food (sugar) or fuel (ethanol) had four main targets:

- ◆ to improve the balance of payments (through a reduction in the import bill, be it for energy or food);
- ◆ to stimulate the local capital goods industry;
- ◆ to reduce regional disparities through decentralized industrial production units in poor regions of the countries;
- ◆ to reduce income disparities through creation of low-skilled jobs in rural areas.

The sugarcane industry and its related markets remain a highly regulated sector. In order to build up national industrial production capacities, governments resorted to a wide range of

policy tools. The role of market forces was limited to the effects of international price changes affecting state planning. Supply and demand for major sugarcane products (and by-products, to some extent) were (and partially remain) disconnected from each other. Therefore, no price formation on a competitive basis followed the meeting of supply and demand.

State intervention exists to the extent of defining four types of parameters:

- ◆ quantities produced and sold by each production unit (through quotas allocated annually to each production unit in different production regions);
- ◆ buying prices (at the factory gate) and selling prices (at the consumer level) for the major sugarcane products (including sugarcane);
- ◆ cost of capital;
- ◆ quality of products being sold.

Two basic ideas underlie these policies, contributing to the formation of what we will call an incentive system and shaping the biomass-based

industrial sector. Both are found in Brazil and India, in somewhat similar forms.

The first follows the principle of import substitution policies. Incentive given to private actors, mainly in the form of low interest rates on capital, acts as a catalyst for investments in the sector. The government delivers licences to set up production units of a predefined size, which provide a planned additional supply. The state's priority is to build up a national supply capacity.

The second idea proceeds from the first. In order to maintain production capacity at the estimated level, fixed prices are given to the supplier for his products by the government according to a formula based on an annual survey of the production costs of the industry. An average production cost (unit cost) is calculated and a mark-up is added to it, the final price given to each producer being at least equal to the highest unit production cost. This allows units with high production costs to carry on contributing to the country's supply. (This could act as an incentive to these producers to innovate, in order to minimize costs and therefore maximize their rents.)

Public efforts went mainly towards developing economic conditions to maximize aggregate production levels rather than to minimize unit production costs. Such a strategy depends heavily on government capacity to fund the required investments (through public debt, tax collection or money creation).

The Brazilian Alcohol Programme

Institutionally-monitored growth

In the 1970s, a growth and slump in the international sugar market were both conducive to continued support in the form of soft loans from the government to the sugar agro-industry. The growth of the sugar price up to 1973 triggered a wave of government-financed investment, eventually leading to overcapacity in a depressed world sugar market.

In 1975, the Alcohol Programme allowed the industry to put idle land back into production. Sugarcane was processed into alcohol, thanks to the simple addition of distilleries to existing

Other topics

sugar factories. Ethanol price and demand were guaranteed by the government. Anhydrous alcohol was mixed with 80 per cent petrol in conventional vehicles.

From 1978, the continued rise in world oil prices led the government to total substitution of petrol by lower-priced hydrated alcohol in a new type of vehicle fuelled by pure ethanol. This would create an irreversible demand for alcohol, aided by Brazilian car-makers.

This time growth in production was sustained owing mainly to distilleries financed up to 80 per cent by the government, with negative interest rates. A new breed of investor was drawn to alcohol production by this financial bounty: sugarcane growing and distillation consortia were set up by Brazilian banks, foreign investors, and Brazilian equipment manufacturers.

This has led to overcapacity from 1986 to the present. Sources of finance were dried up by Brazil's debt crisis in 1982 and recurrent inflation, limiting possibilities of money creation to fund the sector. Growth in production had to slow down despite added capacity coming on line, due to the government's lowering of the buying price of alcohol to fight inflation. However, ethanol-powered cars remained subsidized and ethanol demand soon exceeded supply, ending in a shortage in 1990. Sales of alcohol-driven vehicles dropped from 100 per cent of total car sales in 1989 to about 20 per cent in 1993.²

Unachieved objectives

Redistribution of rural income

Small and medium-sized cane growers were driven out of business by subsidized sugar producers, who increasingly produced their own cane. As a rule, crop surfaces expanded throughout the 1970s and 1980s, while land ownership was concentrated. Cost reductions benefitted from decreases in hand labour wages, which dropped in real terms,³ mainly because of endemic rural unemployment and the economic recession which affected Brazil in the 1980s, so that crop harvest mechanisation, for instance, remained uneconomical.

Reduction of discrepancies in regional economic development

Despite subsidized equalization of the costs of alcohol production and transport (through the state monopoly for production and distribution of petroleum products, Petrobras) in the underdeveloped north-northeast region, only a small share of production has gone there and the differences in productivity have widened in favour of the centre-south region, especially the state of São Paulo.⁴

Development of an independent ethanol economy

After years of government-financed investment in autonomous distilleries, alcohol production is still very much a sugar producer's business. Gains in overall productivity have come mainly from improvements in crop productivity started in the 1970s to take advantage of the rise in international sugar prices before the Alcohol Programme, and from the initiative of a few entrepreneurs. Few improvements can

be credited to the equipment manufacturers, who contented themselves with selling identical old technology although they had access to modern imported technology.

The sugar industry in India

From uncrystallized to white sugar: a protected growth

Sugarcane was initially a major crop of the northern states of India for internal consumption rather than for export (as in Brazil). Its main product was sugar in an uncrystallized form (*gur*). In 1932, the Sugar Industry Protection Act boosted the creation of industrial white sugar production units. From the 1950s onwards, the creation of sugarcane planters' cooperative sugar factories was favoured by the government through production licences and capital at preferential interest rates. Sugarcane production expanded in the southern states. States like Maharashtra now represent an important contribution to the national supply.⁵

Major traditional products like *gur* gradually gave way to the production of white sugar. The latter is part of the Public Distribution System, which offers subsidized commodities through ration shops. Sugar price and demand is guaranteed by the government. The state fixes a share of the sugar which the production units have to sell at a fixed price (40 per cent at present).

The cooperative system allowed medium and large farmers to carry on their activities supplying large sugar factories with cane cultivated in small land areas (generally inferior to 10 ha), where intensive cultivation yields an average productivity of 90 tonnes/ha (1980-90).

However, even though the installed capacity is just enough to satisfy internal sugar demand, the cost of promoting new factories is high (Maharashtra State supplies \$3 to 4 million to each new factory) and their economic viability is not evident. In 1991, 28 out of 101 units were considered "sick industries" by the government. Setting up new factories signifies further land occupation in regions where cane cultivation might not be the most cost-effective product for reasons of factor availability (water, etc.). Still, more licences are requested from private investors, who find in sugar production an easy rent thanks to public capital facilities.

Following recent increases in the price of sugar on international markets, and shortages in sugar supply in 1989 and 1994 due to political intervention to favour private importers selling sugar at high prices on the national free markets, several economists are now calling for a complete decontrol of the sugar markets.

Unachieved objectives

Redistribution of rural income

Sugar planters' incomes improved with the development of cooperative sugar factories. The phenomenon of sugar factories shifting to their own production of sugarcane did not take place to the extent it did in Brazil. Land concentration was limited due to regulations on maximum

areas of private property. However, the sugar industry favoured the extension of non-agricultural jobs, absorbing to a certain extent the residual labour force produced due to land concentration.

Reduction of discrepancies in regional economic development

Recent multiplication of sugar factories allowed for a more balanced industrial development at the country level. At the state levels, sugarcane cultivation attracted numerous seasonal workers. As a result, the number of landless peasants increased in neighbouring states or in poorer regions of the concerned states.

Sugarcane development concentrated a large share of public funds dedicated to rural development (especially irrigation) in certain areas.

Development of an independent sugar economy

The government always advocated an extension of production through productivity gains within the existing installed capacity. However, based on the principle of self-sufficiency at the national level, increases in internal demand were satisfied through subsidized additional capacity.

Obstacles to innovation

Many studies demonstrate large technical potential associated with biomass refining. Regarding sugarcane, the potentials lie both upstream, mainly in improvements in sugarcane cultivation, which constitutes the main share of the unit production cost of sugar or ethanol and in the manufacturing process of these products, and downstream in the capacity for producing new goods (electricity, cattle feed, paper from bagasse, high value-added chemical intermediates from molasses or ethanol,⁶ etc.). Although several technologies are readily available, a considerable R&D effort remains to be made.

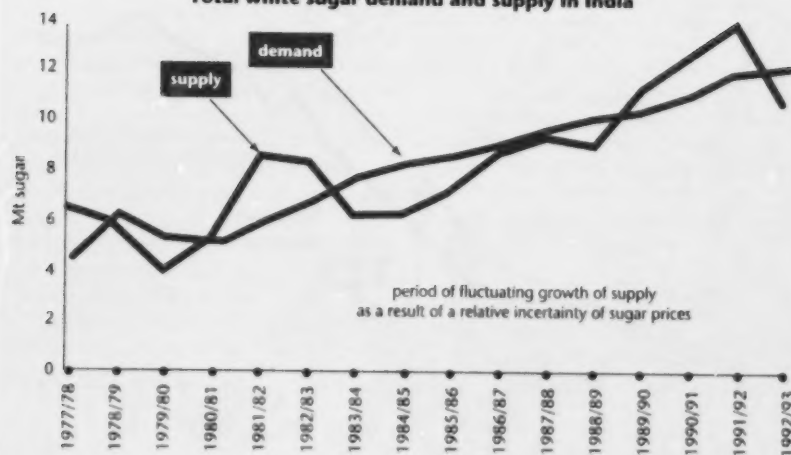
In the field of biomass refining, both a mechanistic conception of innovation (especially of technology diffusion) and market imperfections due to public policies induced relative irreversibilities in the way new challenges for the biomass industry can now be faced.

Firstly, public strategies of investment promotion eliminated certain technological options, and specificities of public R&D did not address the innovation needs of the sector fully. Secondly, private investors in the sugarcane industry developed risk-averse innovation behaviour. Thirdly, weak interaction between biomass refiners and the technology manufacturers caused the absence of a user-producer process of innovation.⁷

Underestimated specificity of biomass production and transformation technology

The specificity of the technology linked to agricultural improvement of cane cultivation requires an important R&D effort from the public agencies, as many innovations cannot be profitably appropriated by private investors (e.g. the seed industry). India's efforts are older than Brazil's in this field.⁸ Countries like Brazil and India can mobilize regular and large

Figure 1
Total white sugar demand and supply in India



Source: ISMA, 1991 and ISMA unpublished data for 1992 onwards

amounts of resources for research, but efforts have been concentrated mainly on the scientific and technical aspects of the improvement of cane varieties. This has led to the use of improved varieties and increased cane productivity per hectare.

Little attention was paid to the institutional capabilities (skilled labour, availability of technical assistance, etc.) of refining units to make full use of new technologies. Dissemination of R&D results remained partial. The need for industrial R&D was not addressed in a sector where in-house adjustments between agriculture and industry are crucial, especially at present when productivity gains can be obtained through process optimization using automation technologies and biotechnologies.

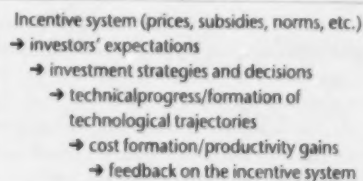
Biomass refining is an industry whose viability depends on the fluctuations of agricultural productivity. This is a sector located in rural areas, far from the sites of conception of new technologies, where specialized labour is rarely available locally. No mechanical diffusion of technologies can be done. Therefore, this is a sector where the benefits of learning by doing are essential to productivity, as it depends on adaptation to local conditions (soils, water, temperature, storage, etc.).

Moreover, to build up a supply capacity, public policies emphasized setting up rather identical processing units based on their capacity levels (e.g. a 120,000 litre/day ethanol plant in Brazil or 2500 tonne crushed cane/day sugar factories in India) more than on their adaptation to local specificities. This both resulted in setting up factories with inadequate (or obsolete) technology at odd locations, and eliminated technological alternatives such as smaller production capacities or more efficient product and process technologies.

Furthermore, too little R&D was conducted in order to improve the quality and the adequacy of sugarcane products and by-products for the markets.⁹

Risk-averse entrepreneurs

Entrepreneurs play a key role in the innovation process. Apart from their own perception of technology, public policies also shaped the innovative behaviour of the sugarcane refiners. The nexus between the public incentive systems and technological trajectories can be described as follows:



In the sugarcane sector, the incentive system gave a signal in the form of low capital cost. Initially (and ideally) in such a system, there is a rent for almost every production unit entering the market. In spite of inefficiency, production units were guaranteed a reasonable profitability. As the demand increased with time under the pressure of population growth and the changes in consumption patterns,¹⁰ newcomers in the industry were allowed in by the government, the old producers being unable to satisfy the entire additional demand through capacity expansion or scale economies. Moreover, the availability of production factor decreasing in time, areas less fertile and more difficult to cultivate were put under production.

This evolution slowed down the innovation process in the industry and the pace of the decreasing trend in the unit average production cost of the industry for two reasons. First, it allowed for production units with high unit cost and weak production sustainability¹¹ to enter the industry. Second, the newcomers were not necessarily familiar with biomass refining and if they were, they generally had to undergo a period of learning in order to optimize their industrial process according to local agricultural and

other technical constraints.

The existence of a rent for each investor maintained in the market a population of entrepreneurs with a low innovation profile because of their risk aversion, but also because of their location. The latter put them in a situation where they could not innovate without having to face heavy transaction costs. In such an incentive context, the investor choice directs itself more towards expanding the installed capacity (the whole unit production cost curve shifts to the left, unit production cost remaining constant) than towards investing in R&D (the unit cost curve shifts downwards, the minimum unit cost decreases for a constant production level) or in product diversification (the unit cost remains constant with increased production level).

The weakness of the user-producer model of industrial innovation

The weakness of innovation from the capital goods sector

The agro-industry is considered to be "supplier dominated" (Pavitt, 1984). Its size and location make it difficult to conduct in-house R&D to generate the industry's own innovation. Many improvements lie therefore in the willingness and the capacity of technology suppliers to conduct R&D and to provide new technologies. The import substitution policies' aim was to offer the private investors a set of conditions allowing them to set up production units destined to satisfy the internal demand for consumer goods. Most of the technology used in the manufacturing sector was therefore imported or developed locally within joint ventures. More often than not, the production units of this sector were smaller in size than their equivalents in industrialized economies (more so in India than Brazil in the sugarcane industry) and more vertically integrated, given the lack of maturity of the industrial structure. Moreover, the size, organization and functioning of the internal markets and the public regulations ruling them led to monopolistic or oligopolistic competition in the markets for technology (Katz, 1994).

Such configurations of the technology markets led to a certain type of R&D from technology suppliers which remains today. It is generally more oriented towards an extension of production capacities than towards possibilities for product differentiation or quality improvements. Such R&D also contents itself with the adaptation of products and processes within the firms. It does not look towards the technology frontier which would have pushed the technology suppliers to envisage more joint ventures with public R&D institutions or with international suppliers.

Biomass refiners' attempts to build a user-producer process of industrial innovation.

Conscious of the need for innovation to increase their rents (or simply survive in more competitive markets than those for sugar and ethanol), some biomass refiners engaged in cooperative R&D using their own units as experimental fields.

Other topics

Two examples can be quoted: the Technological Centre of Copersucar (CTC) in Brazil (created in 1979; invested \$20 million in R&D in 1990/91; Ruiz Olalde, 1992) and the Vasantdada Sugar Institute (VSI) in India (1980). They both carry out their own R&D programmes in the agricultural and industrial fields related to sugarcane refining. This form of cooperative research has been possible mainly because those cooperating belong to a homogenous, regionally concentrated group of production units. It was also viable as long as their common perception of risk motivated them to gather their resources.¹² The replicability of such an effort is therefore rather restricted. Incentives have to be designed to ensure a long-term permanence of such cooperative R&D. In a depressed economic context, even the most innovative entrepreneurs have a tendency to cut on R&D expenses to face short-term constraints.

New stakes and issues in policy design for biomass

Regulating the production system described at the beginning of this article is viable as long as the state is able to bear the financial burden of maintaining such an incentive system. When the opportunity cost of maintaining and expanding a biomass-based industry is high,¹³ the governments are quite capable of dropping their support for the industry. This is why, in the context of foreign exchange constraint and restrictive fiscal policies, many economists advocate strategies promoting exports and liberalisation in order to reduce inefficiencies due to market imperfections through direct contact with the international competition to trigger innovation and cost reduction. In this context, the contribution of the industrial sugarcane biomass transformation sector to the fulfilment of national targets (food or energy security) is then put in question in countries such as Brazil or India, as refiners might shift to more remunerative markets.

There is a great risk of having to face disruption in the system for adjustment of supply to demand, creating costly shortages at the national level as happened for ethanol in Brazil in 1990 or for sugar in India in 1989 and 1994. These man-made shortages show that such a system of regulation cannot be partially supported or liberalized. There are no halfways in their management.

Policies of import substitution constrained integration and fragmented the innovation process by allowing for the permanence of market imperfections. Amongst the biomass refining entrepreneurs, the heterogeneity of behaviours which existed initially remained, though unplanned. If protection was required to let the national industries build up, incentive systems introduced a relative irreversibility in the existing technology structure and entrepreneur behaviours, limiting the efficiency of future choices based on the new liberalization strategies. For example, the weakness of the capital goods industry is a bottleneck in export strategies as it plays an important role in national technological



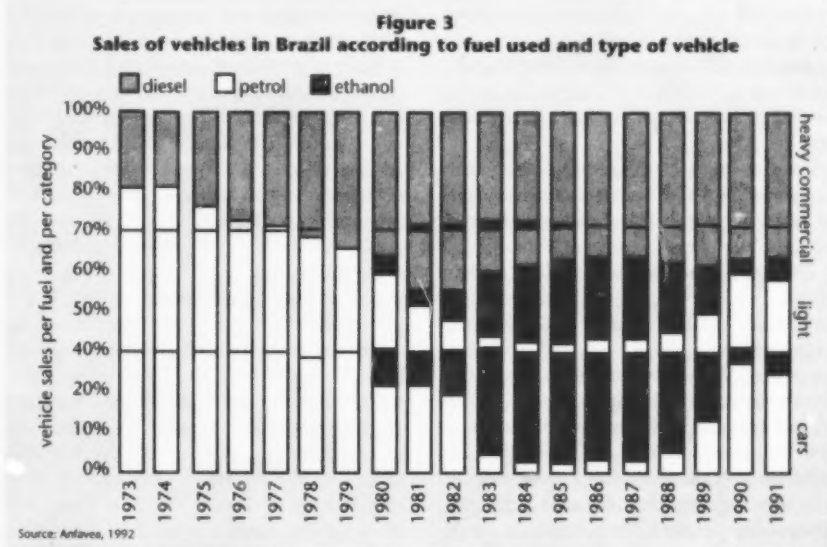
capacities (Unger, 1988) to keep the competitive edge. The dependence on technology imports for innovation and industrial growth further limits the possibility for export strategies in a context of limited foreign exchange. Therefore, the debate over protection of the infant industries cannot be completely dismissed and new forms of public intervention have to be thought of.

The scale of operation of biomass refineries, their location, and the lack of risk-taking entrepreneurs makes it difficult for all of them to enter highly competitive markets (such as the one for chemical intermediates). In the scenario of a liberalization of this sector in Brazil and India, we believe in country-specific policies in order to benefit from the heterogeneous existing production capacities.

Two aspects of the problem are to be addressed. The demand aspect: removing subsidies on sugarcane products, for example, should be done

according to a predetermined calendar to give enough time to the firms to reduce their demands and to redirect their production (e.g. the automotive industry processing ethanol-powered cars, or the food processing industry consuming sugar). And the supply aspect: though exports seem to be a real but limited opportunity, there is also a large scope for national alliances to be built to supply other industries with raw materials and intermediate products from sugarcane, or to supply local markets with new final products.

However, going back to the initial public targets, the changes in the system might not help to limit regional and social disparities. There is an obvious risk of further concentration in land and capital. New products based on biomass, and new institutional configurations, will have to be evolved to help economically depressed regions design their own solutions aimed at more dynamic economic activity.



Other topics

The new role of the state ought to involve less direct intervention in the definition of demand and supply quantities and prices, but a reorientation towards more discriminating incentives and actions to stabilize actors' expectations of taxes and prices through institutional development such as:

- ◆ stabilization funds;
- ◆ public procurement of bulk quantities of goods for economically weak consumers (sugar in India);
- ◆ public facilities and funds for R&D purposes;
- ◆ coordination facilitating design of contracts within the context of the emergence of new markets (especially in the field of energy), to modify the perception of risk and risk sharing between existing partners (including the state) and to allow for new funds to be raised (locally or internationally) in order to pay for the required additional investments.

References

ANFAVEA (1992) *Statistical Yearbook*. Anfaeva, Industria Automobilística Brasileira, São Paulo.

Audinet, P. (1994) Sugarcane Bagasse: Processing Technologies and Marketing. *Economic and Political Weekly*, XXIX/48, November, M149-M155.

Audinet, P. and La Rovere, E.L. (1993) Environmental Benefits of the Brazilian Ethanol Programme. *Proceedings of the First Biomass Conference of the Americas*, 29 August-2 September, Burlington.

COPERSUCAR (1989) *Prodcool, fundamentos e perspectivas*, 2nd ed. Copersucar, São Paulo.

COPERSUCAR (1990) *IV Seminario de tecnologia industrial*. Copersucar, São Paulo.

COPERSUCAR (1991) *V Seminario de tecnologia agronomica*. Copersucar, São Paulo.

Dosi, G., Freeman, C., Nelson, R., Silverberg, R. and Soete, L., eds. (1988) *Technical change and economic theory*. Printers Publishers, London.

Fulmer, M.E., Ogde, J.M. and Williams, R.H. (1990) *Cogeneration applications of biomass gasifier/biomass turbine technologies in the sugar cane and alcohol industries*. CEES/Princeton University, Princeton.

Gupta, T. and Ahuja, V. (1990) *Economic and policy issues for bagasse-based paper and newsprint in India*. Oxford and Ibh Publishing, New Delhi.

Hugot, E. (1970) *La sucrerie de canne*. Dunod, Paris.

ISMA (1991) *Indian Sugar Year Book 1990-91*. Indian Sugar Mills Association, New Delhi.

La Rovere, E.L. and Krause, G. (1992) The use of combined cycle system for excess electricity generation in the sugar industry. *Proceedings of the 6th European Conference on Biomass for Energy, Industry and Environment*. Elsevier, Brussels, 897-903.

Katz, J. (1994) *Technologie, Economie et Industrialisation Tardive*. Salomon et al., 251-278.

MME (1992) *Balanço Energético Nacional 1992*. Ministerio de Minas e Energia, Brasília.

Patureau, J.M. (1981) *By-products of the cane sugar industry*, 3rd ed. Elsevier, Amsterdam.

Pavitt, K. (1984), Sectoral patterns of technical change: towards a taxonomy and a theory. *Research Policy* 13, 343-374.

Ruiz Olalde, A. (1992) *Capacitação tecnológica na agro-indústria canavieira: o caso da Copersucar*. Master's dissertation, University of Campinas, Campinas.

Salomon, J.J., Sagasti, F. and Sachs-Jeantet, C., eds. (1994) *La quête incertaine, Science, Technologie, Développement*. Economica/United Nations University Press, Paris.

Unger, K. (1988) *Industrial structure, technical change and microeconomic behaviour in LDCs*, Dosi et al., 480-493.

Notes

1. A previous version of this article was presented at the 8th European Conference on Biomass for Energy, Environment, Agriculture and Industry, Vienna, 3-5 October, 1994.

2. To maintain their profitability, Brazilian sugarcane refiners shifted to the production of sugar. Sugar production units with ancillary distilleries have the capacity to shift their production of cane juice to sugar or to ethanol, according to changes in the final selling prices.

3. From \$3.74/tonne in 1978 to \$0.98/tonne cut in 1992 in São Paulo State; \$US in June 1992; Audinet, 1994.

4. Ethanol productivity has been multiplied by 1.4 in litres/ha between 1975 (2981) and 1991 in the southeast region (which includes São Paulo State) and by 1.3 in the northeast region (2246.6 litres/ha in 1975).

5. 15 per cent of total sugarcane production and 35 per cent of white sugar production in 1989/90, against 44 per cent and 27 per cent for Uttar Pradesh, the main northern producing state.

6. See, for example, La Rovere and Krause, 1992; COPERSUCAR, 1989, 1990 and 1991; Fulmer et al., 1990; Gupta and Ahuja, 1990; Patureau, 1981; Hugot, 1970.

7. On the specific issues of sugarcane bagasse pro-

cessing technologies and marketing for energy, see Audinet, 1994. The diffusion of bagasse processing technology is limited by three problems (one on the supply side and the others affecting the demand for bagasse energy products): the cost of technology; the quality of the final products as compared with their conventional competitors (fossil fuels); the price of the final products of sugarcane bagasse (level and stability over time).

8. India's Sugar Breeding Institute of Coimbatore was created in 1912. A sugarcane variety improvement programme was initiated in Brazil only at the beginning of the 1970s (Planalsucar in 1971).

9. A major exception: the Brazilian government supported R&D at the end of the 1970s to develop the ethanol-fueled engine.

10. In India, total consumption of white sugar increased from a little less than 5 million tonnes in 1980/81 to almost 10 million tonnes in 1990/91. In Brazil, total consumption of ethanol increased from 2.9 billion litres in 1980/81 to 11.9 billion litres in 1991/92 due to the subsidies for the purchase of ethanol-powered cars.

11. Low availability of cane being one of the main problems.

12. One can notice the following criteria of cohesion: these cooperative R&D efforts were carried out by southern sugarcane refineries (CTC is located in São Paulo State in Brazil and VSI in Maharashtra State in India) in order to keep a competitive edge over their northern competitors. VSI is smaller in size and more oriented towards labour training.

13. The macroeconomic appraisal of large biomass programmes is a difficult task, as shown in the case of the Brazilian Ethanol Programme where sugarcane ethanol replaces petrol. Amongst the sources of controversy, the following examples can be quoted: petrol was (and is) an important source of tax revenue for the government, as the profit margins are high for this product; while ethanol production and consumption expanded, the petroleum was becoming locally available through exploration of new fields, lowering the threat of energy dependency; with the oil countershock of 1986, the ethanol option is questioned as its production cost compared with that for petrol is still superior; with the shift to ethanol consumption, the Brazilian petroleum refining capacity had to deal with large sunk costs to restructure its refining capacity, in order to satisfy the change in consumption patterns towards less petrol and proportionately more diesel. ◆

Other topics

Pollution prevention strategy at an H-acid manufacturing unit

N. Venkatesan, Assistant Director, and A.K. Saxena, Sr. Deputy Director, Industrial Pollution Prevention and Control Division, National Productivity Council, Utpadarka Bhavan, Lodi Road, New Delhi-110 003, India

Abstract

H-acid is a dye intermediate. In India, it is mainly manufactured by small and medium-sized enterprises (SMEs) with a production capacity of between ten and 100 tonnes per month. The promotion of various types of employment-generating SMEs in India has resulted in multi-media pollution problems. Through the implementation of simple pollution prevention measures, substantial cost savings can be obtained in an H-acid manufacturing unit. For example, process modification can increase product yield as well as reducing the COD load to wastewater treatment systems.

Résumé

L'acide H est un composant de colorants. En Inde, il est principalement produit par les petites et moyennes entreprises (PME) dont la capacité de production varie entre 10 et 100 tonnes par mois. Le développement de différents types de PME indiennes génératrices d'emplois a entraîné de problèmes de pollution « multimédias ». L'application de mesures simples de prévention de la pollution permettrait une réduction significative des coûts au sein d'une unité de production d'acide H. Ainsi, une modification du processus de fabrication peut accroître le rendement du produit tout en réduisant la charge DCO qui parvient aux systèmes de traitement des eaux usées.

Resumen

El ácido H es un tinte intermedio. En la India se manufactura principalmente en pequeñas y medianas empresas (PYMES) con una capacidad de producción entre 10 y 100 toneladas al mes. La promoción de diversos tipos de PYMES generadoras de empleo en la India ha resultado en problemas de contaminación en distintos medios. Mediante la puesta en práctica de simples medidas de prevención de la contaminación se pueden obtener sustanciales ahorros en los costes en una unidad de manufactura de ácido H. Por ejemplo, la modificación del proceso puede aumentar el rendimiento y reducir la carga de COD en los sistemas de tratamiento de aguas residuales.

H-acid (1-Amino, 8-Naphthol, 3-6 disulphonic acid) is one of the dye intermediates used in the manufacture of acid, reactive and direct dyes. It is manufactured mostly by small and medium-sized enterprises (SMEs) with a production capacity of 10-100 tonnes per month (TPM). In India, SMEs are considered as employment generators. Consequently they are usually built on the fiscal regime of incentives, subsidies and tax concessions with little attention paid to productivity and resource conservation. On the other hand, promotion of these units has created multi-media pollution problems.

Due to the gradual abandonment of manufacture of toxic dye intermediates in the developed countries, most of these SMEs turned out to be potential foreign exchange earners. This trend calls for establishing the peaceful coexistence of environmental protection and economic development in this sector.

This article concerns the considerable savings (US\$ 60,000 per year) that can result from the implementation of simple pollution prevention measures in a typical 10 TPM H-acid manufacturing unit. Through process modification the product yield is increased by 7.7 per cent, result-

ing in the elimination of about 40 per cent COD load to the subsequent wastewater treatment system. Potential areas for hazardous waste minimization and exchange are also highlighted.

Introduction

The dyestuff industry in India made remarkable progress during the 1960s and 1970s. There are at present over 1000 units in the small-scale sector engaged in the manufacture of dyes and intermediates. Most of these units are located in the western part of India, i.e. the States of Gujarat and Maharashtra.

H-acid (1-Amino, 8-Naphthol, 3-6 disulphonic acid) is one of the dye intermediates used in the manufacture of acid, reactive and direct dyes. The unit discussed in this article is located in the Odhav industrial estate of Ahmedabad district, in the northwestern region of India.

Due to the usage of high-strength acids and alkalis in the manufacture of H-acid, the combined wastewater stream was contaminated with high chloride and sulphate content. In addition, the presence of toxic naphthalene-based dye intermediates in the wastewater made it non-biodegradable.

In order to meet the existing terminal stan-

dards, these industries have to install capital-intensive and more sophisticated treatment systems, with heavy recurring costs. Therefore, the feasible alternative was to implement various pollution prevention measures using a "methods approach", with the objective of not only optimizing chemical usage but also reducing the pollution load to the subsequent wastewater treatment system.

Manufacturing process and waste generation

H-acid production was a batch process. On average, 30-34 batches were carried out in a month. Naphthalene was the starting material for H-acid synthesis. It was subjected to a series of chemical reactions like sulphonation, nitration followed by neutralization, reduction, fusion and isolation. The H-acid slurry after isolation with sulphuric acid was filtered in a Neutuch filter, centrifuged, dried and packed. A schematic production process indicating the sources of pollution is shown in Figure 1.

Based on the wastewater survey conducted at this unit, the "pollution inventory data" presented in Table 1 were evolved.

All the above mentioned discharges were batchwise. In order to simulate the characteristics of combined factory discharge which would serve as a design basis for the subsequent wastewater treatment system, a volume-proportionate sample designated as "factory composite" was prepared in NPC's laboratory.

Based on the above data, and by studying the various unit processes and operations involved in the H-acid production, the following in-plant pollution prevention measures were recommended.

In-plant pollution prevention measures

Process modification

Yield improvisation by the installation of an additional autoclave: around 700 kg of amino solution was produced per batch. Out of this, only 550 kg amino solution per batch was processed in the autoclave (2000 litre capacity). Since the unit had only one autoclave, the remaining 150 kg of amino solution per batch was accumulated for five batches and collected in a wooden vat (7000 litre capacity) and processed in Koch acid route.

The frequency of amino solution processed in the Koch acid route was five batches per month.

Other topics

Figure 1
Production process and sources of pollution¹

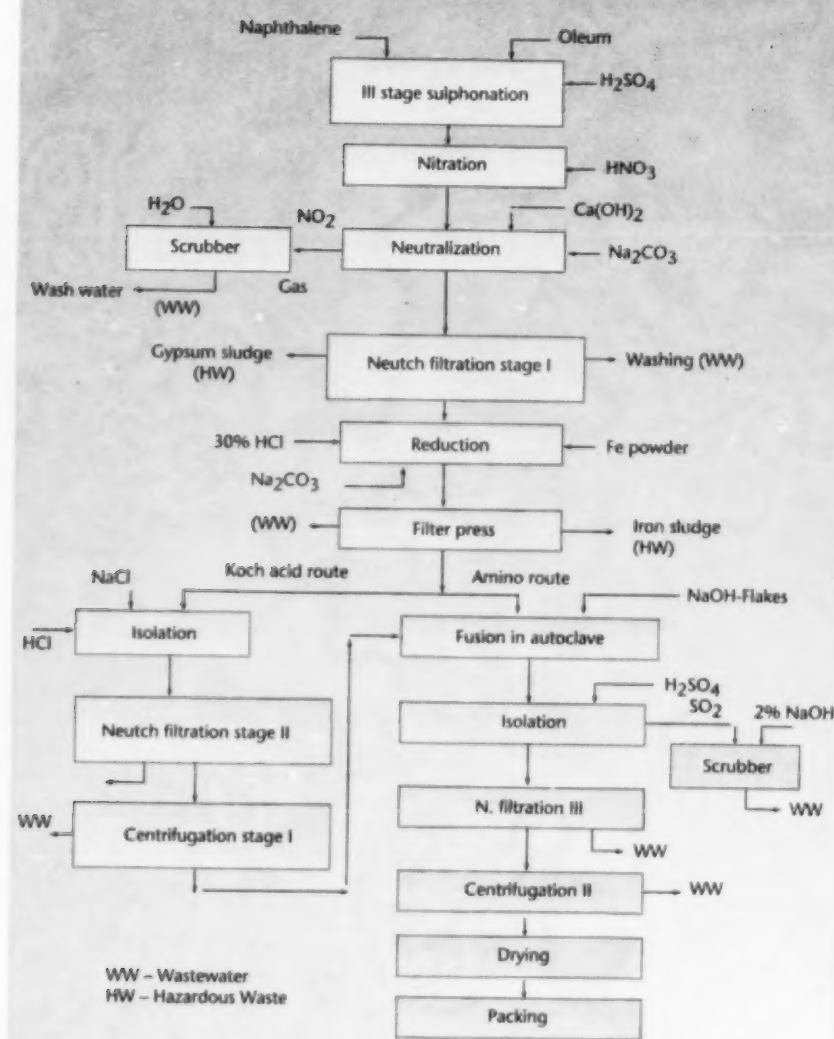
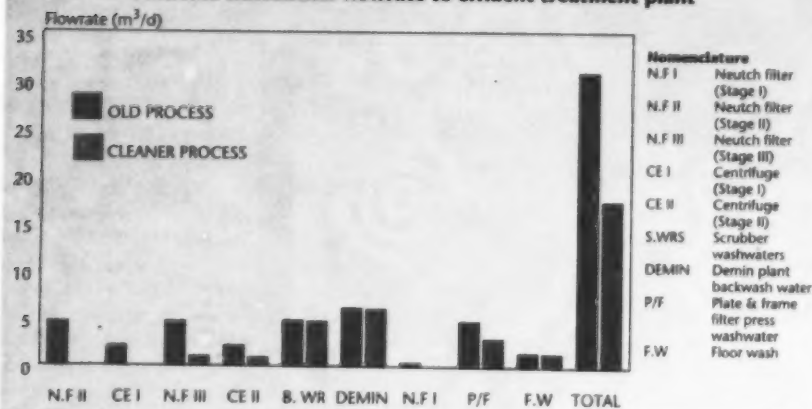


Figure 3
Sectional wastewater flowrate to effluent treatment plant



This clearly indicated that about 3750 kg of amino solution was processed in the Koch acid route in a month. The Koch acid route involved the loss of (around 160 kg/Koch acid batch) intermediate in the Neutuch filter filtrate cum washing and centrifuge filtrate cum cloth washing.

Moreover, in the Koch acid route the specific consumption of caustic (0.25 kg of Koch acid/kg of amino solution processed in the Koch acid route) was 7.7 per cent more than that in the amino route. This problem was overcome by installing an additional autoclave of 2000 litre capacity.

The economics of this option are presented in Table 2.

The installation of an additional autoclave not only produced annual savings of around Rs. 10.8 lakhs (US\$ 36,000), but also eliminated the generation of toxic wastewater streams from second-stage Neutuch filter and first-stage centrifuge. The above economic calculation amply demonstrates the payback period for the installation of an additional autoclave to be less than a year.

Recycling

Neutuch filtration - stage I (after neutralization)

Washing of the Neutuch filter contributed (0.35-0.5 m³/batch) around 1.5 per cent to the combined wastewater discharge. This was collected in a drum of 500 litre capacity and reused in the neutralization vessel as a make-up for fresh water (around 1500 litres of fresh water was used) in the neutralization vessel.

Filtration in plate and frame filter press

Filter press washing constituted around (4.7 m³/batch) 15 per cent of the total combined wastewater discharge. On average, about 50 kg of amino solution per batch was lost in the filter press leakages, initial bed scouring and wash-water streams. Around 70 per cent of the total amino loss was recovered by the implementation of the following measures:

- ◆ A collection tray below the P/F filter press was provided to collect leakages from the P/F interface, which were recycled to reduction vessel.
- ◆ The wastewater from initial bed loosening (around 0.7 m³/batch) was filtered over a wooden vat (7 m³ capacity) in order to filter out the ferric oxide particles, and the clear filtrate was reused as a make-up to the water added in the reduction vessel.

The economics of this recycling is given in Table 3.

This recycling operation produced a monthly savings of about Rs 60,000/- (US\$ 2000) as against the investment required for the installation of a wooden vat and a recycle pump.

Segregation of toxic concentrated streams

In view of the toxic and non-biodegradable nature of the (low volume and high COD & TDS streams) concentrated streams from the Neutuch filter filtrate and centrifuge mother

Other topics

liquor, it was recommended to collect these streams separately at their respective sources and send them to a solar evaporation pond. However Research and Development (R&D) efforts are needed to find out the possibilities of producing cheap quality dyes from these concentrated streams. Due to this simple segregation, the COD load in the residual wastewater treatment stream was reduced by 92 per cent.

The impact of these pollution prevention measures on the production process is depicted in the process block diagram in Figure 2.

The impact of the pollution prevention measures described above on the combined wastewater flowrate and COD load is shown in Figures 3 and 4.

Areas for further investigation

Process control

The soluble losses of H-acid from Neutuch filter filtrate and centrifuge mother liquor ... analysed to be around 115 kg/batch. The reasons for this amount of loss are attributed to:

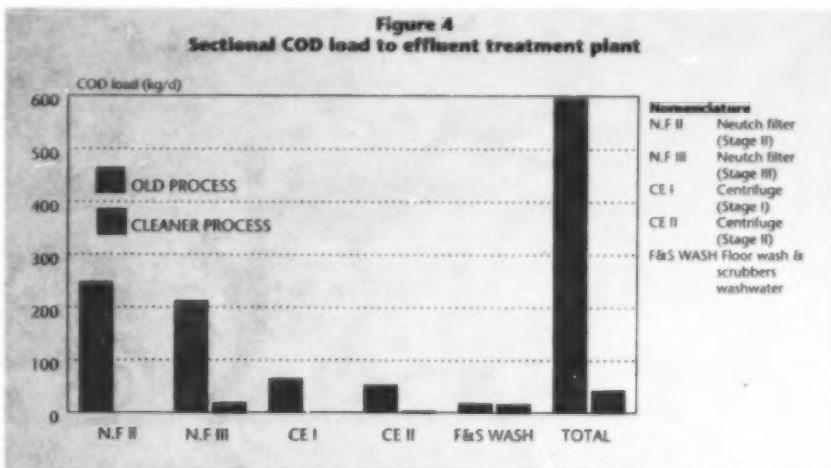
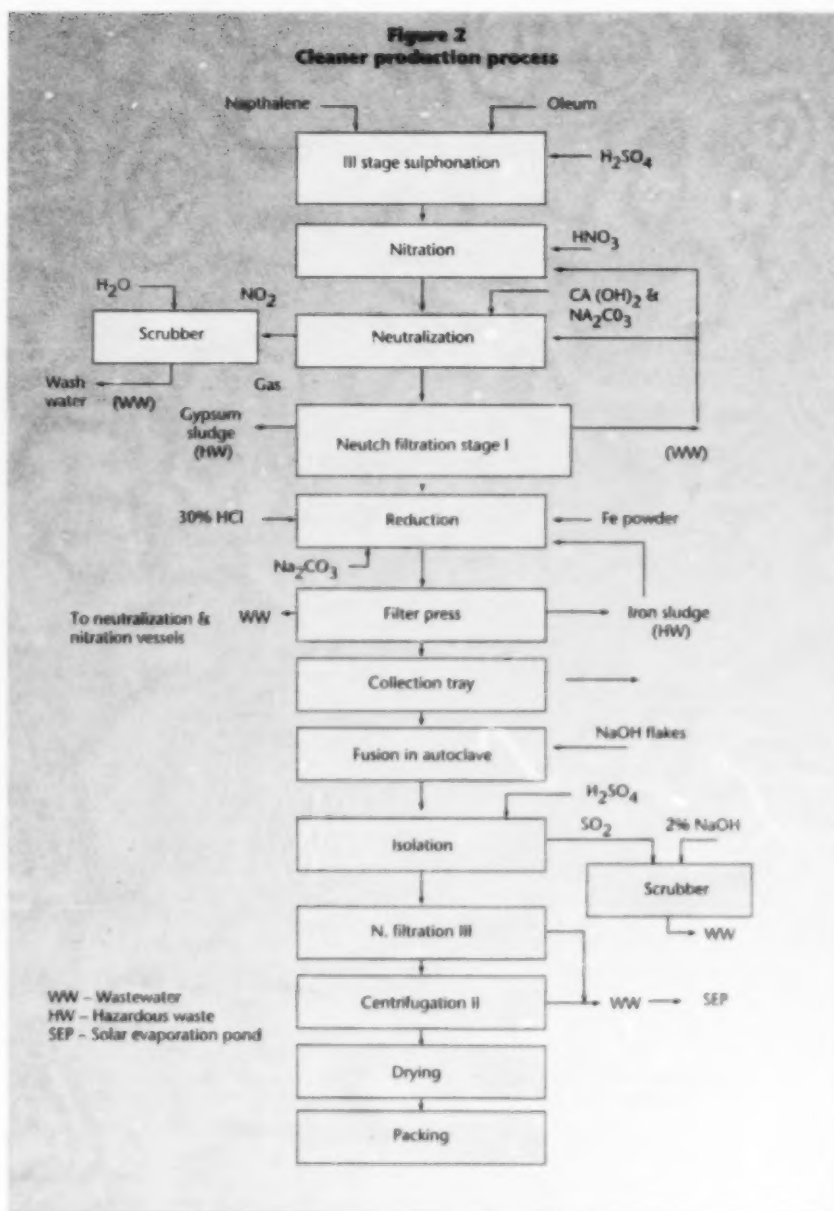
- ♦ inherent limitation in the kinetics of various reaction stages which ultimately lead to the formation of isomers;
- ♦ improper control of reaction parameters like temperature, pressure, etc.;
- ♦ the excessive usage of acids and alkalis starting from sulphonation to isolation step. Due to this, sodium salts (NaCl and Na_2SO_4) get accumulated in the H-acid slurry, further inhibiting the precipitation rate of H-acid in the acidic medium;
- ♦ no closer pH control.

By using a digital pH meter (at the time of study, the unit was using pH articles) at each and every reaction stage, excessive addition of acid and alkalis could be brought down. Through closer control of the pH, especially at the isolation step, the H-acid loss in the concentrated streams could also be brought down to a considerable extent. However, this measure requires closer supervision by experts during implementation.

Elimination of gypsum sludge generation?

In order to separate the nitro naphthalene sulphonic acid from sulphuric acid, lime and soda ash were used to precipitate the sulphuric acid as calcium and sodium sulphate respectively. This resulted in 11-12 tonnes of gypsum sludge generation per tonne of H-acid manufactured. Gypsum sludge contained 0.5-1 per cent nitro naphthalene compounds.

Through solvent extraction of organic acid from the inorganic acid, followed by distillation system, pure nitro naphthalene sulphonic acid could be produced and the gypsum sludge generation could be eliminated. By means of this technology's adoption, the purity of the H-acid produced will also be high. However, a detailed techno-economic feasibility study has to be conducted to ascertain the application of this technology, to allow the scale of operation prevailing in this unit.



Other topics

Table 1
Wastewater characteristics

S. No	SOURCE OF WASTEWATER/ INTERMEDIATE PRODUCT	FLOW RATE m ³ /d	pH	COD mg/l	NITRO MASS (%)	AMINO MASS (%)	KOCH ACID (%)	H-ACID (%)
1.	Neutch filter I wash water	0.35	6.9	2600	0.24	-	-	-
2.	Plate & frame filter press inlet	-	-	-	-	19.0	-	-
3.	Plate & frame filter press outlet	-	-	-	-	17.0	-	-
4.	Filter press bed washing	4.0	7.4	640	-	-	-	-
5.	Filter press initial charging	0.7	7.3	1212	-	-	-	-
6.	Floor washing	1.4	7.8	4680	-	-	-	-
7.	Second stage Neutch filtrate (5 times/month)	3.6	2.5	50,000	-	-	4.0	-
8.	Second stage Neutch filter washing (5 times/month)	1.12	3.0	20,000	-	-	-	-
9.	First stage centrifuge mother liquor (5 times/month)	1.12	3.0	40,000	-	-	1.4	-
10.	First stage centrifuge cloth washing (5 times/month)	1.0	6.6	6000	-	-	-	-
11.	Third stage N.F. filtrate (mother liquor)	3.55	1.6	42,580	-	-	-	3.7
12.	Third stage N.F. washing	1.12	1.5	19,000	-	-	-	-
13.	Second stage centrifuge M.L.	1.12	1.6	35,680	-	-	-	1.4
14.	Second stage centrifuge cloth washing	1.0	3.2	5230	-	-	-	-
15.	SO ₂ scrubber water	0.3	4.0	11,750	-	-	-	-
16.	NO ₂ scrubber	4.5	2.5	492	-	-	-	-
17.	Demin backwash	6.1	8.6	224	-	-	-	-
18.	Factory composite	31	2	1900	-	-	-	-
19.	Factory composite (Neutch filters filtrate and centrifuges mother liquor)	22	5.0	2350	-	-	-	-

Table 2
Economics of installation of an additional autoclave

S. No	DESCRIPTION	STATUS (No of Autoclave)	
		Past (1)	Present (2)
1.	No. of amino route per month	25	30 (at least)
2.	No. of Koch acid route per month	5	0
3.	Amount of amino soln processed (kg/month)	17,500	21,000
4.	Yield of H-acid (kg/month)	9750	10,500
5.	Incremental yield (kg/month)	-	750
	Increase in yield (%) Price of H-acid exclusive of excise duty & freight charges (Rupees/kg)		7.7 120
	Annual savings (Rupees)		10.8 lakhs

Note:
Yield of H-acid per kg of amino solution - 0.5 in amino route
Yield of H-acid per kg of amino solution - 0.4 in koch acid route

Catalytic reduction

Iron powder and HCl were used for the reduction of nitro to amino group, resulting in the generation of 3-3.5 tonnes of iron sludge (Fe₂O₃ sludge) per tonne of H-acid. The concentration of amino compound in iron sludge was analysed to be about 4-5 per cent. The amino naphthalene compounds are toxic and carcinogenic in nature. By a catalytic reduction using gaseous hydrogen on the active surface of a metallic catalyst, iron sludge generation could be eliminated.

However, R&D efforts are required in this direction in order to arrive at a cost-effective catalytic reduction system catering to the small scale of operation prevailing in these industries.

These efforts will not only increase the present yield and quality of H-acid production, but also eliminate the pollution problem due to high chloride and sulphate contaminate wastewater streams generated from these reaction steps.

Waste exchange opportunities Reuse of scrubber washwaters

The SO₂ gas generated from isolation step was scrubbed with caustic solution (2 per cent). The concentration of sodium bisulphite in the scrubber water was analysed to be around 8-10 per cent. This stream could be used for the reduction of Cr⁶⁺ to Cr³⁺ in metal finishing waste treatment. This salt solution could be concentrated and

Table 3
Economics of recycling : filtration in plate and frame filter press

Amino loss in the filter press waste	50 kg/batch
Recoverable amino loss due to recycling of bed washing	35 kg/batch
No. of batches carried out/month	30
Amount of amino solution that will be recovered/month	1050 kg
Conversion factor for processing H-acid from amino solution	0.5
Price of 1 Kg of H-acid	Rs 120/- (US\$ 4) (Exclusive of excise duty & freight charges)
Estimated monthly savings	Rs 60,000/- (US\$ 2000)

utilized as a reducing agent in the amination step of gamma acid manufacture.

The NO₂ gas generated during nitration reaction was scrubbed with water, resulting in a dilute nitric acid solution. This waste could be transferred to a cold steel rolling mill where it could be used as a make-up for the pickling bath. However, these areas are to be further studied as there is no organized method of waste marketing prevailing in India.

Waste processing

The iron (ferric oxide) sludge generated from the reduction step could be used for the production of yellow or red iron oxide pigments. One large-scale dye intermediate manufacturing unit in Gujarat is engaged in the production of iron-oxide pigments from iron sludge generated within the plant. However, the economic viability of this process in small-scale industries is still under exploration.

The concentrated streams from the Neutch filter filtrate and centrifuge were recommended to be used as a raw material in the coupling reaction for cheap quality dye manufacturing.

Conclusion

In India, new governmental policies emphasize cleaner production techniques through waste minimization and exchange.

In this light, these areas would be subjected to in-depth investigation in the forthcoming waste minimization studies. In view of the technical complexity and confidentiality involved in the dyestuff production, it will be more appropriate for the industries to take the onus of working towards pollution prevention, as they only need to be given the "waste minimization perspective".

References

1. Hazardous Waste Inventorisation in Gujarat, carried out by National Productivity Council, New Delhi, 1993-1994.
2. Production Integrated Environment Protection - Bayer's experience in H-acid manufacturing. ♦

Viewpoint

Otto Soemarwoto, Executive Director, Indonesian Business Council for Sustainable Development, Gedung Wanabakti, Blok IV, Wing B, Lantai 3, Jalan Gatot Subroto, Sonayan, Jakarta 10270, Indonesia

I&E – In *Changing Course*, published in 1992, the Business Council for Sustainable Development (BCSD) argued that the challenge facing industry – and the world – is to achieve “clean, equitable economic growth”. Could you describe the overall goals of Indonesian BCSD in this context?

Otto Soemarwoto – Environmental awareness has become a hard reality. Consumers are demanding cleaner production. Hence, producers which do not pay adequate consideration to it will in the not too distant future face difficulties in marketing their products. Indonesian industry will not be an exception. On the other hand, it is also a fact that cleaner production sometimes requires additional costs, even though there are paybacks in the long run. However, if handled well, the additional costs would not be wasted money, but could be earned back in higher profitability and competitiveness. The Indonesian BCSD (IBCSD) aims at creating awareness in the Indonesian business community of the importance of cleaner production in enhancing profitability and competitiveness in domestic and international trade. It also aims at stimulating the adoption of cleaner production by providing information on sources of technology for both large industries and small and medium-sized enterprises (SMEs), and on investment opportunities in sustainable development, as well as by helping industry to establish international contacts with partners who have adopted the eco-efficiency philosophy.

I&E – What specific roles do you see Indonesian BCSD playing in order to increase industry's sensitivity towards sustainable development issues, and to improve dialogue between all the relevant partners in Indonesia?

O.S. – Environment in general and cleaner production in particular are being discussed in a very wide circle, including the government, academia, the business community, NGOs and the general public. In general the business community is being blamed as the polluter, as a result of which the business community has adopted a defensive and reactive strategy. IBCSD tries to change this into a proactive strategy in which the business community would take the initiative to create a healthy atmosphere of cooperation with government, academia, NGOs, and the general public. An important step to be taken is, among others, to create dialogue fora to discuss policies, technology, research and technology (R & D), and investment

for sustainable development, and to forge cooperation for enhancing the development of cleaner production. Small cross-sectoral discussion groups and larger seminars and workshops have been organized, which also include guest speakers from abroad. An IBCSD newsletter will soon be published. Articles are also being written in newspapers and popular magazines, and in Indonesian scientific journals. Lectures have been given by the Executive Director to business and academic circles. IBCSD is also actively participating in seminars organized by other organizations. Radio and TV lectures are being planned. Special efforts are being made to bridge the credibility gap between industry and NGOs.

I&E – How important is international communication and cooperation for your organization? Do you feel your situation is representative of business organizations working to promote sustainable development in other developing countries?

O.S. – With GATT's approval and the creation of the World Trade Organization (WTO), Indonesia cannot afford to be left outside the international community. Indonesia also depends heavily on outside capital and technology. Hence, IBCSD has to develop an active international communication and cooperation programme in order to be able to serve its members, and the business community in general, with up-to-date information on conditions and trends of international environmental politics, the environmental movement, and technology. Otherwise we would be left behind and would lose our competitiveness. I think IBCSD is representative of business organizations in developing countries working to promote sustainable development.

I&E – Environmental management tools are becoming increasingly used in industry – for example, environmental impact assessment, environmental auditing and product life-cycle assessment. ISO will soon issue an “environmental” standard. How does Indonesian industry react to this?

O.S. – The general feeling has been that environment is a burden for industry. Recent developments in environmental auditing, life-cycle analysis and eco-labelling are considered as additional pressures from developed countries to preserve their competitiveness. Those pressures are also being felt as unfair, specifically in the case of eco-labelling for tropical forest products. Hence, generally industry is dragging its feet in interna-

lizing environmental costs. However, these pressures are a fact of life and ignoring them would entail very high cost. Consequently, IBCSD is making every effort to convey the message that it is in the interest of industry to become eco-efficient, i.e. to use material and energy more efficiently and thereby reduce both wastes and costs. This seems to be the more effective way, rather than through the teaching of environmental ethics, although this latter should not be ignored.

I&E – Technology transfer is an issue very often discussed on the international scene. What role will BCSD play in that respect? Are there specific developments you would like to see in order to encourage or improve transfer of environmentally sustainable technologies?

O.S. – Technology transfer is very important. However, past experience shows that technology transfer has often been used as a means for marketing outdated technology, and hence the gap between the developed and developing countries has not become narrower, but instead wider. IBCSD, through the World BCSD, is helping industry to seek contacts with partners which are serious about creating a new world of equal partners by providing new cleaner technology and, more importantly, by enhancing the capability of creating new cleaner technology which is appropriate to local conditions. IBCSD is also looking to other international organizations, such as UNEP, in order to be able to access international information at reasonable cost.

I&E – UNEP is promoting a worldwide cleaner production approach aimed at preventing pollution and using raw materials more efficiently. What are the obstacles to implementing this cost-efficient approach widely in Indonesian industry?

O.S. – IBCSD warmly welcomes UNEP's worldwide programme on cleaner production. A joint IBCSD, Bapedal (Indonesian Agency for Environmental Impact Management) and UNEP conference will be held in Jakarta in April 1995. A major obstacle is that industry in general is frightened by the deep-rooted image that taking care of the environment is benefiting society, but at the cost of industry. This additional cost, which the SMEs particularly can ill afford, is hampering the creation of awareness that cleaner production is in the interest of industry. Apart from end-of-pipe technology for waste treatment, there is little information on technology for waste minimization, including better house-keeping technology, which in the long run is cost-effective. Another major obstacle is that the government is solely pursuing the command-and-control approach in pollution abatement. Fortunately, there are signs that changes may occur in the near future through also using economic instruments which would stimulate industry towards self-regulation and the adoption of a pro-active strategy in pollution control, and which hopefully would create the right conditions for a beyond compliance attitude of industry.

Tourism Focus



A regular section reporting on developments in the field of sustainable tourism development and on the activities of the UNEP Tourism Programme.

Australia's national ecotourism strategy

Barbara Jones and Tanya Tear

Commonwealth Department of Tourism, 28 National Circuit, Forrest, ACT 2601, Australia

Abstract

Ecotourism is internationally recognized as a major growth area in the tourism industry. Much of the increase in the number of visitors to Australia results from the growing awareness of its unique natural environment. The Australian Government has recognized the potential economic, social and environmental benefits of ecotourism. The National Ecotourism Programme provides support for projects that improve regional planning and destination management. It also looks at ways to assist in the development of businesses and products.

Résumé

Partout dans le monde, les professionnels du tourisme considèrent le tourisme vert comme un secteur de croissance majeur. En Australie, l'accroissement du nombre de visiteurs résulte pour une grande part d'une prise de conscience de l'environnement naturel unique de ce pays. Le gouvernement australien est conscient des avantages potentiels du tourisme vert sur le plan économique, social et environnemental. Ainsi, le National Ecotourism Programme (programme national pour l'écotourisme) soutient des projets visant à améliorer l'aménagement du territoire ainsi que la gestion des destinations. Il vise également à aider au développement de nouveaux produits et activités.

Resumen

El ecoturismo está reconocido como un área del sector turístico en gran expansión. El aumento de visitantes a Australia proviene en gran medida de la creciente conciencia de su inigualable entorno natural. El gobierno australiano ha reconocido las posibles ventajas económicas, sociales y medioambientales del ecoturismo. El Programa Nacional de Ecoturismo proporciona apoyo para proyectos que mejoren la planificación regional y la gestión de destinos y busca, también, formas de impulsar el desarrollo de negocios y productos.

Australia's tourism industry is thriving. It is already Australia's single largest export industry, accounting for 11.7 per cent of the country's export earnings (1993-94) and employing, directly and indirectly, over 6 per cent of the workforce (1991-92). According to the Tourism Forecasting Council, total international visitor arrivals are expected to reach 3.35 million this year and almost double, to 6.3 million, in the year 2000.

The economic benefits of this continued growth are substantial and widespread – generating increased foreign exchange earnings and employment opportunities, and encouraging significant private investment. But unless it is properly managed, there is also a greater potential for environmental impacts.

The need for ecologically sustainable tourism has attracted increasing global attention. In 1990, the Australian Government established a Tourism Working Group to recommend strategies to implement the principles of ecologically sustainable development to tourism planning, development and management. Many of the Working Group's recommendations were incorporated in the *National Strategy for Ecologically Sustainable Development* in December 1992.

The importance of careful planning to provide for sustainable tourism development and a balanced approach to economic, social and environmental issues was echoed in the Government's National Tourism Strategy, released in June 1992. The Strategy recognized four goals necessary to balance development of this industry, including an environmental goal: "to provide for sustainable tourism development by encouraging responsible planning and management practices consistent with the conservation of our natural and cultural heritage."

Ecotourism Strong interest

Australian Tourist Commission research indicates that a considerable proportion of the nearly three million international tourists who came to Australia in 1993 ranked natural phenomena as major factors influencing their choice of Australia as a tourist destination. The increase in the

number of international and domestic visitors to National Parks and World Heritage Areas supports this trend. For example, Kakadu National Park recorded a four-fold increase in the number of visitors between 1982 to 1991 (Driml and Common, 1994). In addition, a survey commissioned by the Government in December 1994 showed that 53 per cent of adult Australians (just over 6 million people) planned to enjoy a nature-based tourism experience within the next twelve months.

Real benefits

For Australia, ecotourism offers the potential to generate additional foreign exchange earnings, employment opportunities (especially "green" jobs), and other economic and social benefits, particularly in regional areas. For example, total expenditure (not including travel costs) associated with visits to five of Australia's most popular World Heritage Areas amounted to A\$1372 million in 1991 (Driml and Common, 1994). Significantly, more than 50 per cent of this expenditure was on accommodation and services purchased in adjacent regions.

The national ecotourism strategy

The Federal Government considered the formulation of an overall ecotourism policy framework as a vital step towards achieving sustainable tourism in natural areas. Accordingly, in March 1994 the Government released its *National Ecotourism Strategy* as one of a number of major initiatives for sustainable development of tourism in regional Australia.

The aims of the National Ecotourism Strategy were three-fold:

- ♦ to identify the major issues that affect, or are likely to affect, the planning, development and management of ecotourism in Australia;
- ♦ to develop a national framework to guide ecotourism operators, natural resource managers, planners, developers, and all levels of government towards achieving a sustainable ecotourism industry; and
- ♦ to formulate policies and programmes to assist interested parties to achieve a sustainable and viable ecotourism industry.

Tourism

Ecotourism has been defined in numerous ways, and this has led to considerable confusion in the marketplace about what ecotourism actually means in practice. The National Ecotourism Strategy sought to identify and draw together the common elements and provide a clear and focused definition that would distinguish ecotourism from related operations. These elements were, broadly, a focus on the natural environment, ecological and cultural sustainability, education and interpretation, and local and regional benefits. On the basis of these elements, the Strategy defines ecotourism as: *Nature-based tourism that involves education and interpretation of the natural environment and is managed to be ecologically sustainable.*

This definition recognizes that "natural environment" includes cultural components and that "ecologically sustainable" involves an appropriate return to the local community and long-term conservation of the resource.

The National Ecotourism Strategy provides an overall framework to guide the integrated planning, development and management of ecotourism in Australia on a sensitive and sustainable basis.

The Strategy was developed through a wide process of public consultation, including workshops in all States and Territories and discussions with government agencies (at all levels), industry and conservation bodies, and community groups. Complementing this process was a national call for written submissions from individuals and organizations interested in ecotourism.

This input culminated in the release of a *Draft National Ecotourism Strategy* in November 1993 seeking further feedback and comment from a broad range of individuals and organizations – particularly from local government agencies, natural resource managers, tour operators, tourism marketers, planners, conservation and community groups, developers, and Aboriginals and Torres Strait Islanders.

The major issues affecting – or likely to affect – the development of the industry in the foreseeable future were identified through this consultation process as:

- ecological sustainability;
- integrated regional planning;
- natural resource management;
- regulation;
- infrastructure;
- impact monitoring;
- marketing;
- industry standards and accreditation;
- ecotourism education;
- involvement of indigenous Australians;
- viability; and
- equity considerations.

The National Ecotourism Strategy seeks to provide a balanced appraisal of these issues and emphasizes the complementary nature of ecotourism and the preservation of the environment through the adoption of appropriate management strategies. It also provides an action plan to achieve ecotourism's full potential.

The Strategy has attracted significant local

and international attention. Peak organizations including the Australian Conservation Foundation and the World Wide Fund for Nature have endorsed its pioneering approach, and countries including the United States, Canada, South Africa, Peru, Colombia, Denmark, Sweden, Zimbabwe and the Netherlands have expressed interest. It also confirms that there are a number of common interests, including government at all levels, ecotourism operators, State and Territory tourism and land management agencies, and conservation and community groups.

Considerable work on the development of ecotourism has already been done, or is being undertaken, by State and Territory Governments, local governments, industry, and conservation and community groups in the form of policy and planning initiatives. Such initiatives have formed, and will continue to form, an important part of the National Ecotourism Strategy.

The National Ecotourism Programme

The Government's commitment to the development of ecotourism includes funding of \$A10 million, over the four years beginning in 1993-94, to help implement the Strategy through the National Ecotourism Programme.

The Programme aims to sustainably develop ecotourism through innovative projects that will increase Australia's competitiveness as an ecotourism destination, enhance visitor appreciation of natural and cultural values, and contribute to the long-term conservation and management of ecotourism resources.

The Programme is multi-faceted, providing Australia-wide support for projects which improve regional planning and destination management, and investigating areas in which to assist ecotourism operators with business and product development.

Regional planning and destination management

Often the most effective ecotourism planning and development strategies are those approached from a regional perspective. Regional ecotourism planning can improve the capacity of regions to attract foreign and domestic tourists to natural areas, help distribute the benefits of ecotourism widely, and help reduce environmental pressures on peak demand areas. The Programme aims to address the current lack of funds in this area to encourage planning for the long term.

In particular, the project encourages planning processes which:

- recognize ecosystems as their basis, since these (and hence ecotourists) extend beyond administrative boundaries and require integrated catchment and bioregional management; and
- involve local participation in the planning and decision-making process (including consultation with local government, regional development and tourism bodies, natural resource managers, and indigenous and community groups) to ensure wide commitment to a regional plan.

Within a planning framework, the Pro-

gramme provides support for infrastructure projects which provide for visitor access to ecotourism destinations and assist with the management of environmental impacts and physical protection of natural resources. The Programme particularly encourages projects that utilize innovative eco-design and environmentally friendly technology.

Infrastructure projects funded to date have been diverse and have included protective boardwalks and viewing platforms, interpretative centres incorporating solar passive design and other low impact technology, composting toilets, and an underwater nature trail providing interpretive information for divers and snorkellers.

The Programme also provides support for baseline studies and monitoring projects to assess and contribute to the management of changes to natural environments caused by, or likely to occur as a result of, ecotourism activities. This scientific research will provide a more informed basis for decisions by tourism planners, operators and natural resource managers.

Projects have included the development of innovative boat-mooring systems in the Great Barrier Reef (Queensland), monitoring of tourism impacts at wilderness campsites, and monitoring the effects of boat tours on wildlife and visitor satisfaction in Kakadu National Park (Northern Territory).

Business and product development

The Australian ecotourism industry is characterized by small-scale operations offering personalized service. New ecotourism enterprises, in particular, face some very real challenges to their survival in the short to medium term. The National Ecotourism Programme therefore includes a number of initiatives to assist the viability of the industry and its sustainable development. Studies are being conducted in the areas of accreditation, education, market research, business development, and energy and waste minimization.

An issue of major concern to much of the ecotourism industry is the apparent misinterpretation of ecotourism (by some operators, consumers, marketers and others) and the corresponding problem this poses for the international credibility of the industry and the sustainability of Australia's natural attractions. In response, the Government formed an industry-led steering committee to investigate the feasibility of a national ecotourism accreditation system.

Extensive consultation with ecotourism operators and other interested parties formed the basis of the study. A series of workshops was held at key locations around Australia, and these were supplemented by questionnaires, written submissions and qualitative telephone interviews to gather a broad cross section of industry views. These views have been incorporated into a report providing initial recommendations on issues such as who or what should be accredited, eligibility criteria, draft accreditation standards, powers of administering bodies, levels of accreditation, fee structure, and review mechan-



Boardwalks combined with viewing platforms are an effective means of providing for visitor access to ecotourism while protecting natural resources.

isms. The report has been presented for public comment to determine the preferred course of action by the industry and those likely to be affected by any accreditation scheme.

Accreditation offers the opportunity to raise industry standards generally, and to provide a degree of quality assurance in a highly competitive market. The improved protection of the natural environment on which ecotourism depends is another major outcome of a successful accreditation scheme which will encourage appropriate practices and more informed decision making by ecotourists. However, widespread acceptance of and commitment to a scheme will be vital to its success.

Supporting the accreditation initiative is an *ecotourism education* programme to promote an increased level of awareness and understanding of the principles and practice of ecotourism to a range of audiences including the media, the tourism industry, education and training bodies and consumers.

The project will establish current and future education needs of the ecotourism industry, tourists and others, develop communication strategies and an awareness programme for identified target groups, and assist the media and tourism marketers to better apply ecotourism principles to their promotional activities. In addition, a range of educational materials will be identified and developed for use by educational institutions.

Extensive *market research* is being undertaken to assess the nature and level of demand for Australian ecotourism experiences. This study will facilitate both a detailed analysis of existing data on ecotourism and the collection of additional

primary information to determine the supply of and demand for ecotourism product, the market profile of "ecotourists", and the economic and social significance of ecotourism. This research addresses a major information gap identified in the National Ecotourism Strategy. It will enable the industry to develop new ecotourism product and target new markets with increased effectiveness.

Improving the overall *business skills* and environmental knowledge base of ecotourism operators is the target of another study under the Programme. Many of the challenges to establishing ecotourism businesses are similar to those applying to other small business operations, but with added industry needs related to the size and accessibility of the market, the cost of seasonal operations, and in some cases a lack of experience and knowledge of the tourism industry. To address these issues, the project will investigate the establishment of networks and alliances for co-operative marketing, purchasing and skill-sharing to provide competitive advantages for small or developing ecotourism businesses.

Another Programme initiative is directed at promoting the increased knowledge and use of *energy and waste minimization* initiatives among ecotourism operators to increase their capacity to provide quality ecotourism experiences in an ecologically sustainable manner. The study involves an international investigation of best practices in energy and waste minimization initiatives in related industries and a national consultation process with Australian industry and government. Because cost is often perceived as a barrier to the adoption of these practices, the project also aims to evaluate the economic and

marketing benefits of adopting such environmentally responsible practices.

Conclusion

The National Ecotourism Programme is a package of interrelated and complementary ecotourism initiatives that, collectively, will reduce the barriers to the sustainable development of ecotourism and help spread its economic and employment benefits throughout regional Australia. They will also make a major contribution to environmental conservation and management.

Ecotourism can be a catalyst for encouraging the broader tourism industry to be ecologically sustainable. Nature-based tourism activities, and many aspects of the tourism industry generally, can learn much from this promising young industry. Ecotourism is, in many ways, setting the standards for the rest of the industry to follow.

Copies of the National Ecotourism Strategy can be obtained by contacting:

The Director – Nature Based and Indigenous Tourism Section
Department of Tourism
PO Box 1545, Canberra ACT 2601, Australia
Facsimile: 61 6 279 7234

References

- Commonwealth Department of Tourism (1992) *Tourism, Australia's Passport to Growth: A National Tourism Strategy*, AGPS, Canberra.
- Commonwealth Department of Tourism (1994) *National Ecotourism Strategy*, AGPS, Canberra.
- Driml, S. and Common, M. (1994) Economic and Financial Benefits of Tourism in Major Protected Areas, *Proceedings of Tourism Ecodollars Conference*, 13-16 April, Mackay, North Queensland. ♦

TOURISM NEWS



Sports and environment – a perfect match

There is magic about the Olympic Games and sports competition in general which makes them an ideal vehicle for transmitting the environmental message. It was therefore with great enthusiasm that UNEP and the International Olympic Committee (IOC) signed, in July 1994, a co-operation agreement to promote environmental protection, not only in future Olympics but also in other international sporting competitions. As stated by Mrs Elisabeth Dowdeswell, UNEP's Executive Director, in her address to the Centennial Olympic Congress, "The discipline and sense of fair play young people acquire through sports can be easily translated to their relationship with nature."

A joint IOC/UNEP Conference on sports and environment is to be held in Lausanne, Switzerland, in April 1995. UNEP, with a technical expert from the Lillehammer Olympic Organizing Committee on its board, will develop guidelines for host and bidding cities and for sports competition in general. It will also be part of a working group which will develop, in collaboration with the IOC, a plan of action for promoting respect for the environment.

For further information, contact UNEP Information and Public Affairs Branch, P.O. Box 30552, Nairobi, Kenya. Fax: +254 (2) 226 886. ◆

"Going green makes cents"

"Going Green Makes Cents" was the theme of the environmental session of the International Hotel Association (IHA) 1994 Annual Congress, held in October in Sydney, Australia. Organized through the International Hotels Environment Initiative (IHEI), the session brought together individual hoteliers, and chief executives of many of the world's leading hotel groups and hotel associations, to examine the business benefits of environmental action and explore opportunities for networking environ-

mental know-how. The Congress concluded with environment being recognized as a key issue of concern for hotels worldwide.

For further information, contact the International Hotels Association, 80 rue de la Roquette, 75544 Paris, France. Fax: +33 (1) 47 00 64 55. ◆

Partnerships for progress

Friends of the Earth have set up working groups in the Mediterranean, Spain, Italy, Malta, Cyprus and Portugal, aiming at defining and implementing measures to improve the environmental situation in the existing strongholds of tourism in this region. These working groups, comprising environmental and cultural organizations, local and regional authorities, and members of the business communities, are preparing projects to improve environmental conditions and the setting up of local partnerships. The projects currently underway vary according to possibilities in given destinations and include environmental courses in tourism schools, coastal planning, waste management, camp site management, and a public sensibilization campaign through news media. During 1995, the Friends of the Earth Mediterranean network aims to expand the initiative to other Mediterranean destinations.

For further information, contact Mr Neil Rock, Tourism coordinator for Friends of the Earth International, Jose Clapes 4, 17800 Ibiza, Spain. Fax: +34 (71) 30 71 10. ◆

Publications

UNEP/IE has published Technical Report N° 29 on *Environmental Codes of Conduct for Tourism*. The purpose, objectives and benefits of codes are outlined, and the content of the main existing codes presented. Tools and programmes to support the implementation of codes and monitor the results achieved are reviewed.

This publication can be ordered from UNEP/IE.

Also available from UN Publications, CH-1211 Geneva 10, Switzerland or New York, NY 10017, USA. ◆

Workshops and meetings

Thailand

In Cha-Am, Thailand, on 13-15 February 1995, UNEP/IE and the UNEP Regional Office for Asia and the Pacific jointly convened a regional workshop on "Sustainable Coastal Tourism", in co-operation with the UN Economic and Social Commission for Asia and the Pacific (ESCAP). Over 35 representatives from governments, non-governmental organizations and the tourism industry from Indonesia, Malaysia, Maldives, Philippines, Sri Lanka, Thailand and Vietnam attended. Following the regional meeting, over 50 representatives from the Thai Government, provincial and local authorities, the tourism industry and local communities met at a UNEP national workshop to discuss sustainable coastal tourism in Thailand in general and, more specifically, the Hua-Hin Cha-Am region.

Participants in these workshops committed themselves to identify further actions to be taken, to form networks for pursuing the exchange of experiences and information, and to report on the results achieved.

Spain

On 16-17 March 1995 in Cadix, Spain, the World Tourism Organization and the Municipality of Cadix convened an International Forum for Parliaments and Local Authorities focusing on the qualitative aspects of tourism. Mrs Jacqueline Aloisi de Larderel, Director of UNEP/IE, delivered a keynote address on Tourism and the Environment.

Further information can be obtained from:

WTO

Capitain Haya 42,
28020 Madrid, Spain.
Fax: +34 571 37 33. ◆

World News

Japan's policy for industry and environment

Japan has an active approach to industry and environment issues involving several government departments, including the Environment Ministry and the Ministry of International Trade and Industry (MITI). MITI is encouraging Japanese industry to increase its voluntary efforts to conserve the environment. The ministry has taken three main measures to achieve this.

First, in 1992, the Industrial Structure Council, Energy Advisory Committee, and Industrial Technology Council of MITI formulated "fourteen proposals to restore the earth through harmonizing the environment, economy and energy." MITI's second main approach has been to ask the main industrial groups to formulate voluntary plans on the environment. In 1992, 90 industrial sectors were asked to develop such

UNEP IE now has an E-mail address:
uneple@unepl.fr

plans. In December 1993, MITI produced a status report on plans developed by 320 companies which account for about 60 per cent of the total sales of Japanese manufacturing industry.

Third, the Global Environmental Affairs Committee of MITI's Industrial Structure Council formulated an "Environmental Vision of Industry" in July 1994. This involves several components:

- ◆ Identification and review of environmental impacts in 15 industrial sectors, followed by proposals for new measures and ways for these to be integrated into corporate activities.
- ◆ A focus on future trends in environmental measures. These include development of environmentally friendly products; development of recycling and waste disposal technologies; and increasing the environmental awareness of consumers through corporate activities.
- ◆ A reduction in environmental impacts through inter-industrial collaboration, such as cooperation between companies generating recyclable wastes and companies that could utilize these wastes as raw material.
- ◆ Promotion of the environmental industry, including manufacturers of pollution control equipment, and also other sectors that can contribute to reducing the burdens industry places on the environment (see table).

For more information, contact H. Tsukamoto, Deputy Director-General, the Ministry of International Trade and Industry, 1-3-1 Kasumigaseki, Chiyoda-Ku, Tokyo, Japan. Tel: +81 (3) 3501 4724, Fax: +81 (3) 3580 6347. ◆

Environmental Protection in Korea, 1994

Korea has just published a report which reviews environmental quality and environmental protection efforts in the Republic of Korea, with a detailed description of both aspects for 1993. Among environmental highlights of 1993, the report notes that sulphur dioxide emissions were cut "drastically", mainly due to the increased use of liquid natural gas and low-sulphur oil. Dust emissions also fell; but despite these improvements, air pollution in the Republic remains unsatisfactory. In the field of water pollution, several initiatives were taken during 1993, but much more remains to be done. Pollution standards were met in only 22 per cent of rivers, and

only 39 per cent of sewage and other wastewaters received treatment before discharge. Most solid waste is dumped without treatment in the Republic's 590 landfill sites, including the 19,000 tonnes of industrial waste generated annually.

In the field of chemicals policy, the report notes that 17,000 chemicals are in use in the Republic, compared with 35,000 in Japan, 79,000 in the US, and 90,000 in the European Union. The large number of new chemicals being developed worldwide is flagged as a concern of South Korean policy-makers. When new chemicals are introduced or imported from abroad, evaluations of them are made. The report notes that some other countries have criticized this system as a "non-tariff trade barrier disguised as an environmental protection measure."

In addition to reviewing these areas of environmental protection in detail, the report discusses other subjects including: environmental science and technology development; public funding mechanisms for environmental protection; options for strengthening pollution prevention as opposed to control; approaches to enhance public awareness of environmental issues; and international environmental cooperation.

(1994). Ministry of Environment, The 2nd Government Complex, Kwacheon 427-760, Republic of Korea. Tel: +82 (2) 504 9244, Fax: 504 9280. Pbk, 292p. ◆

"Second generation" waste minimization programme launched

Cleaner Production is a broad approach, covering pollution prevention, of which waste minimization is a part, as well as efficient use of raw materials (see Industry and Environment Vol. 17 N°1). A number of initiatives are increasingly launched under the "waste minimization" banner, testifying to the growing awareness about the need to promote a preventive rather than a cure and restore one.

The West Midlands Waste Minimization (WMWM) scheme aims to help industrial companies in the area to cut the £733 million (about \$1.1 billion) they spend annually on waste disposal. It is one of the first projects to receive support from the Environmental Technology Best Practice Programme set up by the UK Government in 1994, which has a budget of £16 million over five years. The project will run over two years. In the first year, consultants will conduct environmental audits of participating companies and implement straightforward waste minimization initiatives. In year two, environmental management systems will be put in place to ensure that waste minimization becomes part of the corporate culture. Some 35 companies in the West Midlands region have expressed inter-

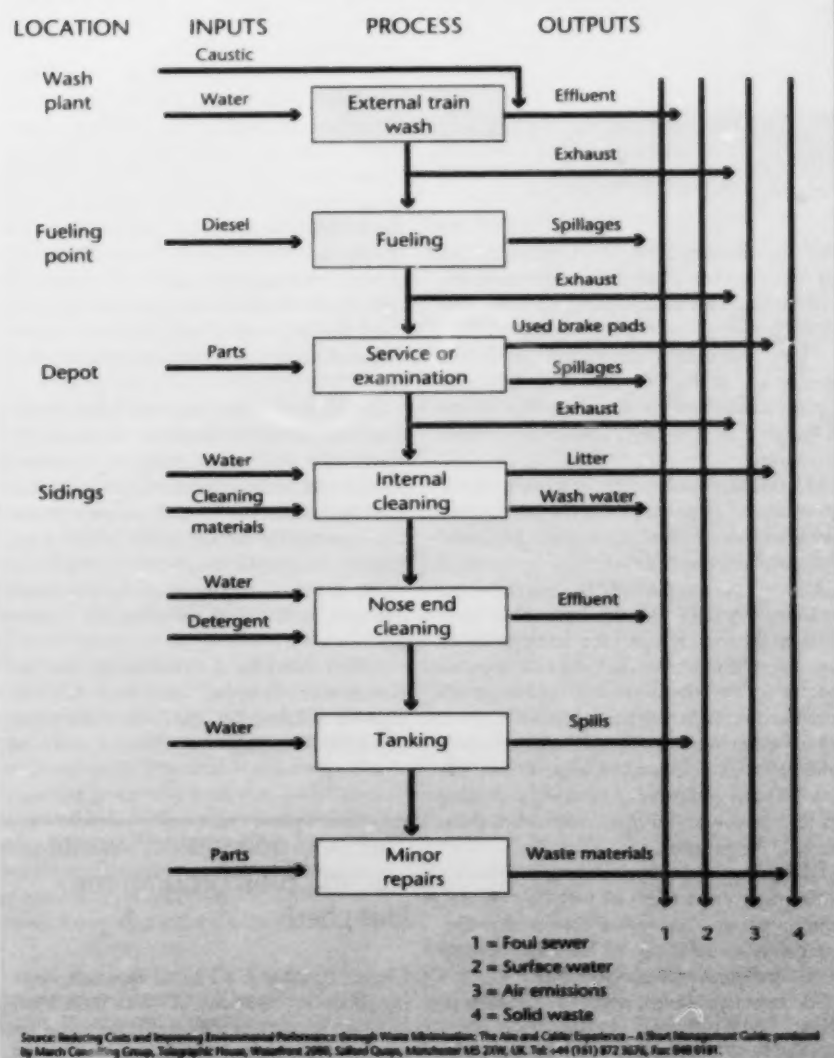
Japan's environment industry
(US\$ billion)

	1990	2000	2010
Pollution prevention and environment preservation equipment	7	11	19
Waste disposal and recycling equipment	4	6	11
Environment analysis equipment	0.5	1	1
Environmental consulting	1	2	4
Environmental conservation sector	13	20	35
Waste disposal business	38	53	73
Recycling business	51	73	106
Sales of used products and repair business	20	36	50
Waste disposal and recycling sector	109	162	228
Environmental restoration business	0.5	1	2
Environmental creation business	8	14	23
Environmental restoration sector	9	15	24
Efficient supply of energy related business	18	22	28
New energy related business	1	9	12
Environment-friendly energy supply sector	19	31	40
Environment-friendly products sector	2	6	23
Total	153	233	350

Source: Ministry of International Trade and Industry

NB The figures do not all add up perfectly, due to rounding and because some sectors overlap.

**British Rail locomotive cleaning process flow diagram:
an output from the Aire and Calder Project**



est in becoming one of the WMWM's core 15 companies, including firms operating in food, plastics, metals, chemicals and engineering.

WMWM is a "second generation" waste minimization scheme because it builds on earlier experience in Britain (see box), and because, compared with previous projects, it has a number of new features. The first of these is that ten of the project's 15 core members must be small and medium-sized enterprises (SMEs). This is a new departure because SMEs were little represented in earlier projects. Environmental performance of SMEs is acknowledged as an important area of weakness in environmental policy making in many countries. SMEs tend to have less financial or other resources to invest in environmental protection than larger companies, and a smaller degree of commitment to maintaining initiatives once launched. Yet, due to their large numbers, SMEs are significant contributors to environmental pollution in all countries.

The second novel feature of WMWM is that it involves the creation of a "snowball" fund, which is explicitly aimed at tackling the problem of maintaining the momentum of waste minimization initiatives once the scheme is operational. The fund, whose name recalls the tendency of snowballs to grow as they are rolled along, involves the recycling of 5 per cent of consultancy costs to help future participants in the scheme build on the experience of the core companies. The project's managers hope that the fund will enable WMWM to become self-financing in the longer term.

WMWM's third novel feature is that consultancy companies that work with participating firms - assessing their waste minimization options and designing measures to implement them - will receive most of their fees on a results obtained basis. This demonstrates clearly the confidence that now exists that waste minimization can benefit both the environment and corporate

Prior to the WMWM scheme, experience in Britain with multi-company waste minimization projects was relatively short - going back only to 1992 - but nonetheless productive. The first waste minimization scheme was the **Aire and Calder Project (ACP)**. It was launched in March 1992, modelled on PRISMA, a similar project run in the Netherlands, but based on a single river basin, the Aire and Calder, in Yorkshire. Funding for the ACP was provided by the national government, the regional water company, an industry charity for environmental protection, and participating firms. Eleven companies participated in the project, which ran for two years and focused on minimization of liquid effluent and water consumption. The project cost £400,000, three-quarters of which came from the government, water company and charitable foundations, the rest coming from participating companies.

The project quickly proved a success. By 1994, the 11 participating companies had identified more than 500 opportunities to reduce water consumption and liquid effluent. The 150 waste minimization measures implemented to the end of 1993 saved participating companies £2.2 million annually in water and effluent costs, and nearly three-quarters of the measures had payback times of less than one year. By early 1995, annual cost savings had risen to £3.3 million. Water consumption and effluent generation were cut by 10-15 per cent, and many of the measures also resulted in greater raw material use efficiency and reduced energy consumption. A study of the project estimated that if the measures adopted in the project were extended nationally, British industry could reduce effluent and water consumption costs by £1 billion.

Aire and Calder was followed by a waste minimization scheme in the Mersey region that ran for one year from mid-1993 to 1994, called Project Catalyst. This project aimed at reducing waste releases to all media, and 15 companies participated in it. The total budget for this project was £1 million, half of which was provided by the government and the BOC Foundation for the Environment. Among the project's environmental goals were reductions of 50-80 per cent in effluent charges, 20-50 per cent in water consumption, 10-30 per cent in energy consumption, and 10-30 per cent in solid waste disposal. Again, the project proved a success. Nearly 120 waste reduction measures were implemented, reaping savings in annual operating costs of £2.3 million.

finances, and should also help to meet the costs of sustaining WMWM after its first two years.

For more information on the West Midlands Waste Minimization scheme, contact Ian Harrison, West Midlands Waste Minimization, 36-37 Cox Street, St Paul's Square, Birmingham: B3 1RE, UK. More information on all the waste minimization schemes being supported by the UK Government can be obtained from Peter Cottrell, Department of Trade and Industry, 1 Palace Street, London SW1E 5HE, UK. Tel: +44 (171) 238 2765. ♦

Canadian province paint recycling programme

The first of more than 150 paint collection facilities to be located around British Columbia was opened in January 1995 by British Columbia Environment, Lands and Parks Minister Moe Sihota. The programme is intended to provide consumers with the option of returning leftover paint to retail or to central collection facilities for environmentally sound management.

The paint industry in the province has responded to a paint stewardship regulation passed in July 1984 with three separate plans, which have recently been approved by the environment ministry.

- One leading paint retailer began in January to accept return of all brands of paint, and extended the programme to all its 105 stores around the province during January and February 1995.
- Another firm, with two retail outlets in British

Canadian Environmental Technology Advancement Centres

In partnership with provincial governments, environmental industry associations and the private sector, Canada's federal government has supported the establishment of three Canadian Environmental Technology Advancement Centres (CETACs) to help meet the needs of the country's environmental industry. The CETACs are private sector, not-for-profit corporations, operating at arm's length from government. Their goal is to help small and medium-sized enterprises to commercialize environmental technologies by providing comprehensive technical services, access to investment capital, business counselling, and regulatory and market analysis.

The CETACs are designed to help foster a capacity for sustainable development in Cana-

da, and in particular to support Canada's environmental industry, in line with the Government of Canada's objective to build a world class environmental industry. The initiative to set up the CETACs followed publication in 1992 of a study of the Canadian environmental industry, which analysed its prospects and identified barriers to its development. The CETACs were set up with Federal financing of CA\$ 12 million over four years, which has generated nearly twice that amount in funding from the private sector and provincial governments.

For more information, contact Environment Canada, Technology Transfer Office, Technology Development Directorate, 425 St. Joseph Boulevard, 4th Floor, Hull, Quebec K1A 0H3, Canada. Tel: +1 (819) 953 5669, Fax: 953 9029.

Columbia, has also begun to accept return of used latex-based paints, which it plans to recycle into new products.

- The Paint Care Association (PCA), an industry association representing 47 companies in the province, is pursuing a different, non-retail based strategy. The PCA has been working with local governments around British Columbia to establish fixed and mobile community-based collection facilities. Some mobile paint collection facilities are already in operation; permanent sites are to start operation during 1995. The PCA plan also involves the establishment of community-based paint exchanges, where the public can drop off or pick up leftover paint that

is still useable – therefore reducing the amount of paint requiring disposal. In order to fund these arrangements, an eco fee of about CA\$ 0.12 per litre of paint will be charged at the point of sale.

These efforts provide a good example of corporate environmental responsibility, and of an environmental partnership between industry and other groups, favouring greater environmental protection.

For more information, contact Ron Driedger, Director, Environmental Protection Department, Ministry of Environment, Lands and Parks, 4th floor, 777 Broughton Street, Victoria, British Columbia V8V 1X5, Canada. Tel: +1 (604) 387 9974. ♦

Industry Updates

The Climate Change Debate: Seven Principles for Practical Policies

Written by an independent grouping of industrialists from 15 European countries, the Principles are providing an industry view on climate change. As noted in the introduction, industry, which uses 30 per cent of the primary energy consumed in the European Union (EU), knows it has a necessary role to play in responding to climate change. The document presents progress made by industry in conserving energy through five approaches: improved energy management; investment in new equipment and facilities that

decrease energy use and carbon dioxide (CO₂) emissions; development of new processes to improve energy efficiency; creation of new energy-saving products; and research in all of these areas. It then sets out a framework for policy responses to climate change, which, it says, will enable cuts in greenhouse gas emissions on a "no regrets" basis while safeguarding the competitiveness of European industry (the seven principles referred to in the title). On the basis of these considerations, it attacks the EU proposal for a energy/CO₂ tax. This, the group of industrialists says, "ignores the opportunities to use voluntary initiatives from industry" and "does not meet the criteria for an effective economic instrument." According to the ERT, the proposed tax "will not

meet its environmental objectives, but will damage the international competitiveness of significant industrial sectors in the EU."

(1994). *European Round Table of Industrialists (ERT)*, Avenue Henri Jaspar 113, 1060 Brussels, Belgium. Tel: +32 (2) 534 3100, Fax: 534 7348. Pbk, 24p. Available free of charge from ERT in English, French and German. ♦

One million dollars awarded for waste treatment solution

Companies all over the world are working to reduce industrial pollution, but progress is not being made evenly: some waste streams are especially difficult to treat or eliminate. Even in these cases, innovative approaches can lead to solutions, as Monsanto, a US-based multinational chemical company, has recently found out. After years of effort to deal with one particular waste stream, and having achieved only limited success, the company made an offer in August 1994

News

of \$1 million dollars to any organization that could suggest a way of separating and recovering the constituents. In April 1995, it announced a winner.

With manufacturing plants in 24 countries and worldwide turnover of nearly \$8 billion, Monsanto has the technical and financial muscle to minimize environmental impacts arising out of its operations. The company has also made improving its environmental performance a central corporate goal. Under the 1990 Monsanto Pledge, the firm committed itself to "reduce all toxic and hazardous releases and emissions, working towards an ultimate goal of zero effect," and to favour pollution prevention over end-of-pipe pollution controls.

Whilst progress has been made on many fronts, Monsanto's engineers were unable to come up with a solution to one particular, high-volume liquid waste which is generated at plants manufacturing synthetic fibres, such as nylon and acrylic. The aqueous waste stream contains about 2 per cent organic chemicals, such as fumaronitrile, maleimide, maleonitrile and acrylic acid, and 4 per cent ammonium sulphate, which is added to neutralize the waste stream before disposal.

The waste is not highly toxic, but does contain chemicals classed as "hazardous or toxic" under a 1986 US law¹. Under this law, companies are required to report off-site releases and transfers of more than 300 listed chemicals. Ammonia is one, and Monsanto discharged nearly 55 million pounds of it to injection wells in 1992, about 60 per cent of which was associated with ammonium sulphate. Ammonia discharge represents nearly half of all releases made by Monsanto of chemicals classed as hazardous or toxic.

In 1991, Monsanto launched a programme aimed at reducing by 70 per cent from 1987 to 1995 the amount of SARA Title III chemicals released to injection wells, with essential elimination programmed for 1999. Since ammonia makes up such an important part of this cate-

Teaching and research for cleaner production at the International Institute for Industrial Environmental Economics

The International Institute for Industrial Environmental Economics was created at the University of Lund, Sweden in late 1984, with an initial grant of SKr 200 million. The primary mission of the institute is to train policy and decision makers to work within industry and government; conduct research at the forefront of cleaner production; and support the institutional build-up of cleaner production promotion centres in Central and Eastern Europe and developing countries through the training of competent potential project managers and policy makers. The Institute's teaching programme is based on two degrees, a Master's and a Doctorate in Environmental Management and Policy. Both degrees focus on cleaner production, that is preventive envi-

ronmental strategies based on the pollution prevention pays philosophy, the precautionary principle and the principle of substitution in all areas of society. The first Master's programme, which is entirely in English, begins in summer 1995. The deadline for applications for the Master's programme beginning in 1986 is December 1995. About 60 students are to be accepted into the Master's programme each year.

For more information, contact Professor Karl Lidgren, the International Institute for Industrial Environmental Economics, Västra Mårtensgatan 1, S-223 51 Lund, Sweden. Tel: +46 (46) 109 149, Fax: 104 222, Telex: 33533 LUNI-VERS, E-mail: env_econ@gemini.ldc.lu.se.

gory of wastes, and most of this arises as ammonium sulphate in the waste stream produced by synthetic fibre production, the company redoubled its efforts to eliminate or treat this waste.

Monsanto had some success – both the volume and the concentration of the waste stream have been reduced since 1991 – but neither elimination nor full treatment were achieved. The problem lies in the nature of the waste stream, and particularly its mixture of inorganic compounds (the ammonium salt) and organic chemicals. The presence of inorganic salts in this highly dilute stream made incineration of the organics content virtually impossible. At the same time the ammonium sulphate made recovery of the organics impossible, and vice versa.

The search for a way around this impasse led to the Monsanto Challenge, announced in August 1994. A description of the waste stream was publicized and organizations from any country were invited to submit proposals for a feasible means of separating and recovering the ammonia content. The entries were to be judged

by an independent panel hosted by the Center for Waste Reduction Technologies (CWRT), part of the American Institute of Chemical Engineers. The winner was to receive \$1 million; half immediately and the rest once the process was fully demonstrated to be feasible at industrial scale.

The challenge attracted a good deal of interest from the world engineering and scientific community. Monsanto received more than 180 proposals from research firms, universities, government agencies and individuals from 15 countries. The winner, announced on 3 April 1995, is SRI International, a large, US-based laboratory, engineering and business consulting firm.

SRI's solution contains a number of novel features. It combines three process steps, beginning with a biological one in which a combination of two microbes strip more than 90 per cent of the ammonia out of the waste stream, producing an ammonia rich gas stream. In a second step, conventional gas separation technology is used to recover relatively pure ammonia. A third step recovers usable sulphur compounds.

If, as Monsanto hopes, the technology can be made to work effectively at industrial level, then it will bring a number of benefits. First, it will recover usable ammonia, reducing the purchase bill for new supplies. Second, the removal of ammonia from the waste stream will make possible recovery or effective treatment of the remaining organic constituents of the waste stream, which should make possible the ending of deep well disposal.

The technology, and the way in which it was developed, could also have wider benefits. According to Monsanto, it could find uses not just for the particular waste stream that was made the subject of the Monsanto Challenge, but also for others. The company also says that the experience of making the challenge has shown new ways to creatively stimulate solutions to environmental problems, and that it might issue further challenges in the future.

First International Speciality Conference on Environmental Issues in the Petroleum and Petrochemical Industries

Bahrain
4-6 December 1995

Organized by the Bahrain Society of Engineers and the Saudi Arabia Section of the Air & Waste Management Association, this conference will offer a global view on environmental questions associated with the petroleum and petrochemical industries and provide an open forum for interested parties to exchange technical information on environmental issues. During the past decade, heavy industries have experienced an increased global awareness of environmental regulations and acquired a sense of responsibility at many local or international levels. The conference aims to enable parties to share technical problems and

solutions, as well as to review the latest advances in related products and services. Topics to be covered by the conference include: environmental regulations, environmental impact and risk assessment, environmental auditing, air pollution control, marine pollution and oil spills, wastewater management and reuse, waste minimization, environmental biotechnology, and groundwater protection. UNEP is one of the sponsors of the conference.

For more information, contact the Conference Secretariat, Bahrain Society of Engineers, P.O. Box 835, Manama, Bahrain. Tel: +973 727 100, Fax: 729 819.

The experience could also benefit other industrial companies. Whilst Monsanto is likely to retain ownership of the technology developed, the company stresses that it does not intend totally to limit its use by other firms. In addition, the CWRT is to launch a collaborative programme to further develop some of the other proposals received, several of which are said to be promising. Overall, the Monsanto Challenge shows the value that partnerships can have in stimulating common efforts to overcome common problems.

For more information, contact the Monsanto Company, 800 N. Lindbergh Boulevard, St. Louis, Missouri 63167, USA. (Diane Herridon, Tel: +1 (314) 694 2915). SRI International, 333 Ravenswood Avenue, Menlo Park, California 94025, USA. Tel: +1 (415) 326 6200. Fax: 326 5512. American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017, USA. (Jeff Lenard, Tel: +1 (212) 705 7660, E-mail: jeffl@aiche.org.)

¹ The law is the Emergency Planning and Community Right to Know Act (EPCRA), or Title III of the Superfund Amendments and Reauthorization Act (SARA), which established requirements for emergency planning and community right-to-know reporting on toxic and hazardous chemicals. ♦

The corporate environmental executive

In the last decades, environment has become a major strategic issue for many companies and industries. In response, many companies have created environmental specialist positions, particularly in developed countries. There are now many tens, if not hundreds, of thousands of environmental positions in European and North American companies. "Corporate environmental management is therefore no longer a mere appendage of [industrial companies] but a signifi-

cant element in overall corporate activities, with costs to match," according to a recent report that profiles the growth in corporate environmental executives.¹

The report is based on interviews with senior environmental executives in 32 industrial companies in Germany, the Netherlands and the UK, eight of which are subsidiaries of US parent companies. While much of the report's detailed findings reflect specific European experience, it also contains some possible pointers to the future of the environmental executive in other regions, including in developing countries.

The report detects an evolution in the nature of corporate environmental management over the last decade or so: from reactive to proactive approaches, and from simplicity to complexity. This trend is being driven by greater pressure on companies to improve environmental performance and management, which is affecting industry in all parts of the world. Amongst pressures on industry to clean up are: stricter and more sophisticated national and international legislation, influential environmental movements, greener consumers, and more environmentally aware employees.

The report identifies five stages in the evolution of corporate environmental management. In industrialized, as well as developing, countries, very few companies have progressed through all of them. Environmental leader firms in developed countries have, in some cases, reached the fifth stage; but most companies in most countries have not yet got beyond stage one. The framework outlined in the report therefore describes actual experience in some firms, and possible future developments for others. The five stages are as follows.

- ♦ The initial purpose, and still the minimum starting point for any environmental programme is **legal compliance** with environmental laws and regulations. Failure to comply with these can bring financial penalties, closure of facilities and damage to reputation.

- ♦ Poor environmental performance can also be a major financial risk. This is particularly true in the USA, where civil damage claims can be enormous and Superfund legislation has created a strict liability regime for historic land contamination. As a result, **risk management** is now a second major objective of corporate environmental management.

- ♦ Environmental legislation is becoming increasingly wide-ranging, so that individual companies often need to work with customers, suppliers and other external parties to ensure that compliance is achieved. They are also bound by a growing number of voluntary agreements, with governments, regulators and business and trade associations as well as, in some cases, self-imposed targets. Achieving this **extended compliance** is increasingly becoming an environmental management objective in companies in industrialized countries.

- ♦ In recent years, awareness has grown that individual environmental impacts – for example, those caused by a manufacturing process – are only part of an overall product chain. For companies this means a broadening of the focus of environmental policy to consider also the impacts of suppliers and of the use and disposal of products. Influencing these activities through **product chain management** has become an objective of some advanced companies.

- ♦ The threats and opportunities created by environment-induced changes in markets, costs and other competitive parameters are becoming economically very significant in some industries and countries. This is increasingly making the achievement of **competitive advantage** an environmental management objective for companies.

¹ *The European Environmental Executive: From Technical Specialist to Change Agent and Strategic Coordinator?* Peter James and Stephanie Stewart (1995). Ashridge Management Research Group, Ashridge Management College, Berkhamsted HP4 1NS, UK. Tel: +4 (1442) 843 491. Fax: 841 181. Pbk, 67p. £25.00. ♦



UNEP Focus

Cooperation established on environmental assessment

UNEP, through the new Environment Assessment Programme (EAP), is establishing a global network of Assessment Collaborative Centres in order to provide an international forum and knowledge base for the production of global, regional and sectoral assessments. These assess-

ments aim to support the identification of interlinkages between environmental, social and economic dimensions of sustainable development, and identify emerging issues requiring international attention. They will be designed to enhance the capacity of the global community

for policy and priority setting, taking regional considerations into full account.

The first Collaborative Centre Agreement was with the Dutch National Institute of Public Health and Environmental Protection (RIVM). One of the major tasks of RIVM is to support and assist national environmental policy setting through monitoring, assessment, research, forecasting, and scenario development. The institute has conducted numerous national studies as well as several regional studies, mainly in Europe. At a global, regional and sectoral level it is, amongst other things, providing support to the International Panel on Climate Change.

RIVM has expertise in providing the interface between science and environmental policy setting. The institute has developed innovative approaches and methods to support this activity,

UNEP IE now has an E-mail address:
uneple@unep.fr

News

including the development of models to integrate environmental and socio-economic information and provide user-oriented products.

The UNEP-RIVM collaborative programme concentrates on:

- the development of integrated assessment methodologies, addressing the interactions between environment and development for environmental reporting, forecasting and support to international policy setting; and
- contributions to the production of global, regional and sectoral reports and assessments, such as the Global Environmental Outlook, the Freshwater Assessment, the Source Book on State of the Environment Reporting, the World Resources Report, and globally harmonized indicator development.

Several technical reports have already been produced from the collaboration. These include *An Overview of Environmental Indicators: State of the Art and Perspectives*, and an advanced draft of *Scanning the Global Environment: A Framework and Methodology for Integrated Reporting*. Many more are under preparation.

For more information, contact UNEP EAP, P.O. Box 30552, Nairobi, Kenya. Tel: +254 (2) 623 512, Fax: 623 943, E-mail: eainfo@unep.no. ♦

Expert meeting held on marine pollution from land-based sources

Government-designated experts from about 120 countries met in Reykjavik, Iceland on 6 March 1995, to review and revise the draft Global Programme of Action to Protect the Marine Environment from Land-based Activities. The one-week session was organized by UNEP's Oceans and Coastal Areas Programme Activity Centre, based in Nairobi. The meeting's goal was to define concrete activities for the programme at global, regional and national levels, which will be reflected in a final document to be presented at an Intergovernmental Meeting in Washington, DC in November.

The final preparatory meeting for the Global Programme of Action, hosted by the Government of Iceland, was part of a comprehensive, sequential and coordinated approach to alleviate environmental and health problems related to pollution of the marine environment caused by land-based activities, as proposed in Agenda 21 and approved by the 17th session of UNEP's Governing Council in 1993.

Participants identified specific actions to be taken at the global level to facilitate regional and national programmes that respond to problems caused by land-based pollution – a highly common cause of marine environmental degradation – and that minimize the release of harmful substances into the marine environment. Pollutants introduced into the marine environment, particularly non-biodegradable types, can spread very far from their point of origin. One priority is to

reduce and eliminate pollution by organohalogen and other persistent organic pollutants. A working group was set up to recommend actions in this priority area.

Land-based activities, which include release into the atmosphere, are the source of about 80 per cent of all marine pollution, affecting the 3.5 billion people living in coastal areas – two-thirds of the Earth's population and about 3 per cent of its surface area. This coastal population is projected to reach seven billion by 2015.

UNEP will support the programme's implementation through its Regional Seas Programme, which has a 20-year history of working with governments to protect the marine environment. Financial support for the Global Programme of Action may come, in part, from a revolving fund and the private sector. The fund will provide governments with loans and grants to efficiently and effectively construct and manage waste disposal. Support is also expected from the Global Environment Facility in its allocation of funding for the protection of international waters. The programme and its funding mechanism will assist governments in managing the increasingly serious degradation of the environment as coastal populations double in the next two decades.

The programme mobilizes actions in accord with several global instruments, including the 1985 Montreal Guidelines for the Protection of the Marine Environment from Land-based Sources of Pollution, the 1982 UN Convention on the Law of the Sea, the 1972 London Dumping Convention, the 1989 Basel Convention on Hazardous Wastes, and the Conventions on Biological Diversity and Climate Change agreed at the 1992 Earth Summit.

For more information, contact Mr Peter Schroder, Director, UNEP Oceans and Coastal Areas Programme Activity Centre (OCA/PAC), P.O. Box 30552, Nairobi, Kenya. ♦

UNEP and UN DHA join forces to create an environmental disasters unit

Twenty-four nations meeting in Geneva on 16-17 January 1995 have expressed their unanimous support to UNEP and the UN Department for Humanitarian Affairs (DHA) for their work to improve international capacity to respond to environmental emergencies. The inaugural meeting of the Environmental Emergencies Advisory Group was the first opportunity that countries have had to review the work of the Joint Environment Unit, which was established by UNEP and the Relief Coordination Branch of DHA on 1 July 1994.

The Advisory Group delegates welcomed the practical and positive collaboration between the two UN organizations as being the most effective and efficient way of responding to such disasters. The Environment Unit provided

reports on its activities to date, including the recent UN assessment mission to oil spills in Arctic Russia. The delegates noted the success of the mission in bringing together experts from the USA, Canada, Norway and the European Union and placing them at the disposal of the Russian authorities. The meeting agreed that the mission is a good example of the type of independent, unbiased "backstopping" assistance that could be provided by the Unit working with donor countries for the occasions when bilateral arrangements were not suitable.

The delegates expressed their support for the role of the Unit as: a broker to facilitate quick direct links between focal points in requesting countries and providers of expertise and specialized equipment; an information clearing house to provide rapid access to existing national and international sources of information and advice on response; and the focal point in the UN system for countries facing environmental disasters that are not already covered by existing conventions and UN bodies.

For more information on the Joint Environment Unit, Department of Humanitarian Affairs, Palais des Nations, CH-1211 Geneva 10, Switzerland. Tel: +41 (22) 917 1234, Fax: 917 0023, E-mail: unienet-dialcom141:dhagva, Internet: dhagva@unicc.bitnet. ♦

UNEP IE Update

Each of the following UNEP IE Programmes publishes its own quarterly or biannual newsletter. Here we present summary details of these Programmes' activities in the first quarter of 1995.



Awareness and Preparedness for Emergencies at Local Level (APELL)

• The APELL Annotated Bibliography was published in English and French versions, in December 1994 and February 1995 respectively. The Bibliography describes about 250 of the most important references to help those implementing the APELL process.

• Local APELL Seminar/Workshops were held in January in Haldia, India, and Cilegon, Indonesia.

• An Expert Review Group of UNEP and the International Maritime Organization met on 21-22 February in London to advance the organizations' project to publish jointly a report on APELL for port areas.

The biannual APELL Newsletter is available in English, French and Spanish and is a free of charge supplement to *Industry and Environment*.



Cleaner Production (CP)

• Meeting in February, industry representatives and UNEP IE agreed in principle to develop a product design manual for suppliers of parts for electronic

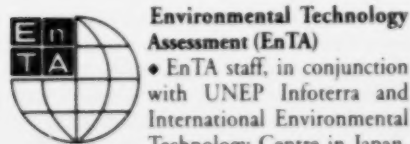
equipment in developing countries and countries in transition to a market economy.

- The Cleaner Production Programme submitted a project document on the National Cleaner Production Centres project to UNEP headquarters for approval and transfer of funds, which was approved by the Executive Director in March. Several centres have begun operation and are initiating demonstration and training activities.

- Two new publications were released during the first quarter of 1995: the final version of *Cleaner Production Worldwide in the APEC Region* (Asia-Pacific Economic Cooperation), and *Government Policies and Strategies to Promote Cleaner Production*. Preparations were made during February for the production of a French version of *Cleaner Production Worldwide*.

- The Core Advisors of the Cleaner Production Programme met in Paris on 27-28 March. The Advisors reviewed the activities undertaken by the Programme and made recommendations for future priorities.

The biannual CP Newsletter is published in English, French and Spanish and is a free of charge supplement to Industry and Environment.



Environmental Technology Assessment (EnTA)

- EnTA staff, in conjunction with UNEP Infoterra and International Environmental Technology Centre in Japan, carried out a survey of information systems and services related to environmentally sound technologies. Over 50 information systems were identified and analysed. An interim report based on this survey was submitted to the Commission on Sustainable Development (CSD), for consideration at its fourth meeting, in April 1995. A final report will be completed in June 1995.

- A consultative meeting of users and suppliers of information systems related to environmentally sound technology (EST) is planned to be held in Paris on 26-28 June 1995. The purpose of the meeting is to review the report submitted to the CSD on this subject and develop a programme to enhance cooperation and comparability between existing and planned systems for exchange of information about ESTs.

- EnTA participated in the UNIDO Round Table on Technology Transfer, Cooperation and Capacity Building for Sustainable Development, held in Vienna, Austria in February 1995. EnTA staff also participated in the UNCTAD Workshop on Selected Cooperation Aspects for Technological Capacity Building in Developing Countries, held in Geneva in April 1995.

The EnTA Newsletter is a free of charge supplement to Industry and Environment.



OzonAction

- The 1995 Work Programme of the OzonAction Programme (US\$ 3 million) was approved by the Executive Committee of the Montreal Protocol.

- In early January, OzonAction posters were distributed to National Ozone Units of developed and developing countries.

tributed to National Ozone Units of developed and developing countries.

- Two in-house consultants joined the OzonAction team in January: Mr Michael White (Australia) and Ms Wei Zhao (China).

- The fourth meeting of the Informal Advisory Group for the OzonAction Programme was held on 20 January.

- A Workshop for Small and Medium-Sized Enterprises on Management of ODS Phase-Out was organized in New Delhi, India on 7-11 February.

- A network meeting of ten ODS officers from southern Latin American countries was organized in Santiago, Chile on 7-11 March.

- The OzonAction Information Clearinghouse Diskette version 2 (OAI.CDV 2.0) was distributed to National Ozone Units of developed and developing countries in early April.

The OzonAction Newsletter is published quarterly and is available free of charge from the OzonAction Programme at UNEP IE/PAC.



Sectoral activities

• Environmental Management in the Electronics Industry

Prepared in cooperation with the UN Industrial Development Organization (UNIDO), the latest publication in the UNEP IE Technical Report series describes options for improved environmental management in the electronics industry. The electronics industry is one of the fastest growing manufacturing sectors, producing the "hardware" for electronic systems, such as semiconductor components, passive components, printed circuit boards, and including also circuit board assembly.

The electronics industry is not pollution-free, and, as it has grown in importance, a number of potentially serious environmental issues have emerged. The discharge of liquid wastes has caused groundwater and soil contamination

with solvents and heavy metals. The disposal, in landfills, of hazardous solid and semi-solid wastes containing heavy metals has caused deterioration of water supplies in the surrounding areas as toxic components have been leached out. Gaseous emissions from electronics component manufacturing facilities have been shown to have effects on the health of the population in the vicinity of the factories: cases of respiratory problems, cancers and sterility have been reported.

In this context, the

purpose of the report is to raise the awareness of personnel in the electronics industry of environmental issues, and to highlight the approaches that industry and governments can take to avoid or minimize environmental impacts. The report introduces the various manufacturing operations associated with the electronics industry, and describes the potential environmental impacts to which these can give rise.

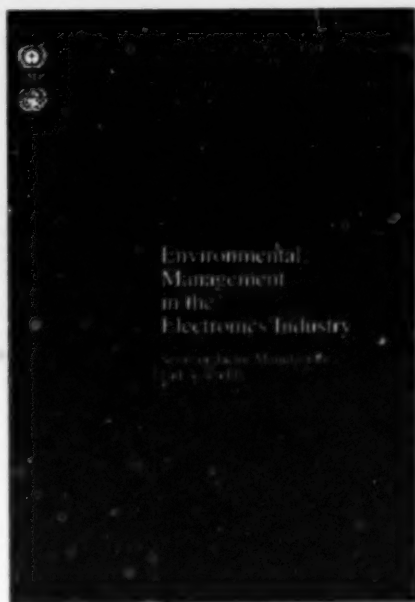
It then focuses on strategies for environmental improvement, emphasizing the possibilities of using a cleaner production approach to eliminate pollution at the design stage and to prevent its occurrence during manufacturing operations instead of having to control it using "end-of-pipe" technologies. The importance of good operational controls for maximizing the efficiency of resource use and minimizing leaks and accidents is stressed, as are the possibilities for waste minimization.

Since it is not possible to eliminate all waste, the report also describes best practice, including low-technology approaches, in the field of waste treatment. Since soil and groundwater contamination are a problem at some older electronics plants, the report goes on to discuss approaches to pollution remediation. Depletion of the stratospheric ozone layer is one environmental issue of great relevance to the electronics industry, because of its historical dependence on chlorofluorocarbons (CFCs) for a number of manufacturing processes. With the deadlines for phaseout of these chemicals under the Montreal Protocol fast approaching, there is considerable pressure on companies to find alternative methods for cleaning components and assemblies. The report describes the main alternatives to CFC use in the electronics industry, including non-CFC cleaning agents and no-clean fluxes.

Finally, the report focuses on policy and implementation aspects of environmental improvement programmes. It discusses how electronics

companies can take an integrated approach to environmental management and describes recent trends in the industry. Within companies, clearly defined responsibilities of employees, explicit environmental policies and targets, and an internal communication and training procedure are found to be amongst the essential elements of improved environmental management.

The report is intended to serve readers in three main groups: those with responsibility for day-to-day plant operations in the electronics industry; those with general



News

management roles; and those in government, regulatory or standards-setting bodies.

Environmental Management in the Electronics Industry: Semiconductor Manufacture and Assembly. UNEP Technical Report N° 23, (1994). UNEP/IE & UNIDO. Pbk, 161p. ISBN 92-807-1410-3. UN Sales N° E94-III-D2. Available from UNEP/IE; from UNIDO, Vienna International Centre, P.O. Box 300, A-1400 Vienna, Austria; and from UN sales agents. ♦

UNEP Industry and Environment in the regions

UNEP ROAP ODS Officers Network for Southeast Asia and the Pacific

The barriers to a rapid phaseout of ozone depleting substances are as much informational and administrative as they are technical and economic. With funding provided by the Government of Sweden, UNEP/ROAP is assisting developing country governments in the region overcome some of these barriers by providing them a means to share information and experiences on a regular basis.

The ODS Officers Network for Southeast Asia and the Pacific, or ODSNET/SEAP, was established in 1992 and aims to promote an early and less costly elimination of the use of ODSs in developing countries. It also encourages developing countries to become Parties to the Montreal Protocol. Present members of the ODSNET/SEAP network are Australia, Brunei Darussalam, Fiji, Indonesia, Lao PDR,

Malaysia, Myanmar, New Zealand, Philippines, Singapore, Sweden, Thailand, and Vietnam.

Activities conducted under the project promote exchange of information among countries in the region. They also familiarize ODS Officers with specific activities in developed countries that have more advanced phaseout programmes.

The ODSNET/SEAP network has consistently shown the benefit of such information sharing. Thailand recently decided to accelerate its ban on installation of new CFC mobile air conditioners based on the experience of the Philippines. Having opportunities to participate in the ODSNET/SEAP activities before they were Parties to the Montreal Protocol helped both Myanmar and Vietnam become more familiar with the Protocol, which enabled them to complete their ratification process more quickly. And the new ODS Officer from Myanmar attended his first meeting of ODSNET/SEAP network in 1994 and learned firsthand of the experiences of other Network members in minimizing the use of ODSs. He returned home and advised relevant agencies in Myanmar of the critical importance of preventing a build-up of outdated ODS technology in that country. As a result, the Ministry of Hotels and Tourism notified potential investors that new installations of CFC chillers in hotel development projects was not allowed.

Although the faster phaseout schedule agreed at the 4th Meeting of the Parties in Copenhagen has yet to be applied to Article 5 countries, several ODS Officers from the ODSNET/SEAP network have underscored at their meetings the necessity of adopting a phaseout schedule which is much more advanced than that allowed under the Protocol. At the January 1995 ODSNET/SEAP meeting, ODS Officers showed a strong interest in information about alternatives to HCFCs, which will enable them to formulate

proper strategies to control the use of these transitional substances. They also suggested that control of methyl bromide use should be discussed at their next meeting. Control measures of HCFCs and methyl bromide stipulated by the Copenhagen amendment have yet to be applied to Article 5 countries.

At their January meeting, ODS Officers also stressed how important it is for Network countries to be involved in international negotiations related to the Protocol and its working groups. Network members agreed that their periodic ODSNET/SEAP meetings provide an opportunity to discuss issues raised by the Open-ended Working Groups, the Executive Committee of the Multilateral Fund, and the four implementing agencies. Such discussion increases the level of participation of network countries in the global efforts to protect the ozone layer.

The initial goal of the ODSNET/SEAP network was to strengthen capacities of ODS Officers from Article 5 countries by having them learn from experience of their colleagues in more advanced countries. Less than four years after the Network was established, it has become evident that much of the experience and information that has been exchanged is among the Article 5 member countries themselves. As most ODS Officers of the Network have become more familiar with the ODS phaseout issue, they have taken a more pro-active approach to this global problem. If the experience of the ODSNET/SEAP project is any indication, we can expect to see Article 5 and non-Article 5 member countries working to restore the ozone layer on a more equal footing.

For more information, please contact: UNEP/ROAP, Regional Office for Asia and the Pacific, U.N. Building, Rajadamner, Ave., Bangkok 10200, Thailand. Tel: +66 (2) 282 9161. Fax: 280 3829. ♦

Air Pollution '95

Porto Carras, Greece
26-28 September 1995

The objective of this third international conference on air pollution is to bring together scientists working in industry, research organizations, government and academia who are working on monitoring, simulation and management of air pollution problems. The conference is being organized jointly by the Wessex Institute of Technology, Southampton, UK, and the School of Engineering, Aristotle University, Thessaloniki, Greece. The emphasis will be on the development of experimental and computational techniques that can be used as a tool for the solution and understanding of practical air pollution problems, from which it is possible to evaluate proposed emission control techniques and strategies. The previous two conferences in this series were held in Monterrey, Mexico in 1993 and Barcelona, Spain in 1994.

For more information, contact Liz Kerr, Conference Secretariat, Air Pollution '95, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK. Tel: +44 (1703) 293 223, Fax: 292 853, E-mail: CMI@ib.rlac.uk.

Books & Reports



includes four maps showing the regions most vulnerable to specific natural hazards, and formulates a number of recommendations for disaster mitigation measures.

Guidelines on Aid and Environment, N° 7 (1994). Organisation for Economic Co-operation and Development, Development Assistance Committee, 2 rue André-Pascal, 75775 Paris Cedex 16, France. Pbk, 56p. ♦

GENERAL

Guide to Environmental Issues

Aimed at US citizens who want to know more about the basic principles of environmental management, and US environmental law and institutions, this booklet could serve as a potentially useful model to other governments looking to increase public participation in environmental matters. In simple, non-bureaucratic language, the booklet introduces basic categories of environmental issues: air pollution, surface water and groundwater protection, pesticides, hazardous waste, public health and community safety. It identifies the legislative framework that has been developed in the US to deal with these issues, and gives a list of government contacts in the Environmental Protection Agency and other agencies that can provide further information. The booklet also contains a glossary of about 300 basic terms related to environmental science and management.

Julie Klaas Pangman, ed. (1994). *United States Environmental Protection Agency, Office of Solid Waste and Emergency Response*, 5502G, Washington, D.C. 20460, USA. Pbk, 84p. ♦

Guidelines for Aid Agencies on Pest and Pesticide Management

The Development and Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development (OECD) seeks to improve and coordinate Member country policies that will integrate development and environment imperatives. The DAC Guidelines on Aid and Environment series is designed to help policy-makers and practitioners address national, regional and international environmental problems. The Guidelines on Pest and Pesticide Management identify three priority areas for

Numbers killed and affected by main disaster types, 1967-91

	N° killed	N° affected
Civil strife/displaced persons	3,076,000	161,265,000
Drought/famine	1,940,000	1,467,510,000
Flood	305,000	1,057,193,000
Cyclone/typhoon/storm	964,000	217,961,000
Earthquake	640,000	42,943,000
Volcano	28,000	1,938,000
Landslide	42,000	3,604,000

Source: Guidelines for Aid Agencies on Disaster Mitigation

development assistance: the promotion of the development and application of integrated pest management; strengthening of pesticide management capabilities in recipient countries; and formulation of good practices in providing pesticides under aid programmes.

Guidelines on Aid and Environment, N° 6 (1994). Organisation for Economic Co-operation and Development, Development Assistance Committee, 2 rue André-Pascal, 75775 Paris Cedex 16, France. Pbk, 46p. ♦

Guidelines for Aid Agencies on Disaster Mitigation

Published in the same series as the title reviewed above, this booklet applies to the main types of natural hazards and disasters: drought, famines, floods, tropical cyclones, earthquakes, tsunamis and volcanic eruptions. The Guidelines are intended to increase awareness amongst policy-makers and project managers involved in development cooperation programmes of the threats posed by natural hazards and of the range of measures that can be adopted so as to reduce the impacts of natural disasters on developing countries. The booklet presents the basic issues,

Consultative Expert Group Meeting on Valuation of Environmental and Natural Resources

This title in the UNEP Environmental Economics Series summarizes proceedings at a meeting organized by UNEP and held on 8-10 August 1994. The bulk of the meeting was taken up with discussions of issues raised by a background document, *Economic Values and the Environment in the Developing World*, prepared by University College, London, the University of East Anglia, United Kingdom, and the University of North Carolina at Chapel Hill. At the end of the meeting, a panel of five experts briefed UNEP Permanent Representatives; a summary of the briefing is included in the meeting report. The main product of the meeting was a set of recommendations which form a framework for UNEP's Programme on Valuation of Environmental and Natural Resources.

Environmental Economics Series, N° 11, Hussein Abaza (1994). UNEP, Environment and Economics Unit, P.O. Box 30552, Nairobi, Kenya. Pbk, 49p. ♦

The Use and Application of Economic Instruments for Environmental Management and Sustainable Development

Immediately following the meeting described above, UNEP's Environment and Economics Unit organized a second, on 10-12 August 1994, to review the use and practical application of economic instruments for environmental protection. This meeting also concluded with a briefing for UNEP Permanent Representatives. The conclusions of the meeting form a set of recommendations for UNEP's Programme in Economic Instruments.

Environmental Economics Series, N° 12, Hussein Abaza (1994). UNEP, Environment and Economics Unit, P.O. Box 30552, Nairobi, Kenya. Pbk, 48p. ♦

Instruments to Promote Sustainable Consumption and Production

This document contains background papers prepared for a seminar held in Stockholm, Sweden on 13-14 December 1994. The seminar was organized as part of the preparations for a symposium on sustainable consumption held in Oslo, Norway in February 1995. The document

Industry and Environment at your service

In reviews of books and reports, all available information is included to help readers locate and obtain particular titles. The following points may be helpful:

In the notes at the end of each review, Hbk and Pbk stand for hardback and paperback respectively. Both hardback and paperback versions of some titles are available. In the case of titles for which payment is required, paperback versions are normally less expensive.

Publishers' telephone and electronic communication addresses are provided wherever possible.

For telephone and fax numbers, the "+" indicates country code. Regional codes (shown here as they would be dialled by international callers) are in parentheses. To save space, international and regional codes are given with just the first telephone or fax number in each book review.

The cost of publications is included wherever possible. Unless otherwise indicated, \$ stands for US dollars and £ for UK pounds. Any title with an ISBN (International Standard Book Number) should be available through commercial booksellers.

News

also contains a summary report of the seminar. Four background papers are presented. The first sets out the background to the sustainable consumption debate, including the context of sustainable development. The second discusses the extent to which green consumerism can be equated with – or differentiated from – ideas of green consumption. The third critically analyses the use and utility of economic instruments to promote sustainable consumption. The last paper describes Nordic countries' efforts to control emissions of nitrogen oxides and to manage waste oil in the context of sustainable consumption concepts.

Nordic Ministerial Council, Stora Stranstrede 18, DK-1255 Copenhagen, Denmark. Pbk, 106p. ♦

Cities for the 21st Century

Cities are both the motor of change and the mirror of our societies. Three-quarters of the world's population now lives in them. Most human activity takes place in urban settings. Resolving urban problems is an essential part of solving the major problems of today. This publication is the result of an OECD conference on the economic, social and environmental problems of cities. The problems at the heart of the debates were the poverty, segregation and distress that characterize numerous neighbourhoods; the physical degradation and the lack of infrastructure and services that characterize others; and the difficulties facing many cities in adjusting to structural economic changes. The solutions advocated in this publication constitute a challenge to our countries' local and national authorities, as well as to inhabitants and entrepreneurs.

(1994). *Organisation for Economic Co-operation and Development, 2 rue André-Pascal, 75775 Paris Cedex 16, France. Pbk, 177p. ISBN 92-64-14287-8. ♦*

Location of Pollution-Intensive Industry in a North/South Perspective: Review of Literature

The FIL Working Paper series aims at documenting the progress of the research programme "Location of pollution-intensive industry in a North/South perspective." Working Paper N° 1 reviews the literature on the question of transfer of pollution-intensive industries from North to South.

FIL Working Paper N° 1, Britha Bergstø and others (1995). Forurendsende Industri-Lokalisering (FIL), Department of Human Geography, University of Oslo, PB 1056, Blindern, 0316 Oslo, Norway. Fax: +47 (2) 285 4828, E-mail: jan.hesselberg@sgo.uio.no. Pbk, 75p. ISSN 0804-5828. ♦

Industrial Pollution and the South

In this FIL Working Paper there are three articles, focusing on: conceptual and theoretical topics on which the research programme is based; a case study of dyestuff production in

Maharashtra; and an overview of the health consequences of pollution and the contribution of industry to this problem.

FIL Working Paper N° 6, Jan Hesselberg & Hege M. Knutson (1994). Forurendsende Industri-Lokalisering (FIL), Department of Human Geography, University of Oslo, PB 1056, Blindern, 0316 Oslo, Norway. Fax: +47 (2) 285 4828, E-mail: jan.hesselberg@sgo.uio.no. Pbk, 95p. ISSN 0804-5828. ♦

ENERGY/CLIMATE

African Conference on Policy Options and Responses to Climate Change: Conference Statement

This conference was held on 5-8 December 1994 in Nairobi, Kenya, to discuss the options for African countries in the run-up to the first Meeting of the Parties of the UN Framework Convention on Climate Change. At the time of the conference 29 African countries had still to ratify the Convention, while 24 countries had already done so. Conference participants stressed the potential significance of climate change for Africa, the importance of the Convention in responding to it, and stressed the need for African countries to be well represented in negotiations under the Convention. The conference statement describes the commitments of developed Parties to the Convention as "clearly inadequate," and considers that "significant emission reductions should be realized by [developed countries] before the issue of stabilization of African emissions can be considered." The statement also notes that African countries have insufficient resources to comply with their commitments under the Convention. It calls on the Convention secretariat and other funding agencies to facilitate the provision of additional funds in order that African countries can "contribute meaningfully to the international climate change mitigation effort."

(1995). *ACTS Press, African Centre for Technology Studies, P.O. Box 45917, Nairobi, Kenya (Tel: +254 (2) 565 173, Fax: 569 989); and Stockholm Environment Institute, Lilla Nygatan*

1, Box 2141, S-103 Stockholm, Sweden. Tel: +46 (8) 723 0260, Fax: 723 0348. Pbk, 25p. ISBN 9966-41-088-0. ♦

Radiative Forcing of Climate Change: The 1994 Report of the Scientific Assessment Working Group of IPCC – Summary for Policymakers

This document is one of four components of a special report made by the Intergovernmental Panel on Climate Change (IPCC) to the first Conference of the Parties (COP) to the UN Framework Convention on Climate Change. The IPCC was established in 1988 under the auspices of the World Meteorological Organization and UNEP to assess the science of climate change, its potential environmental and other impacts, and to formulate response strategies. The IPCC completed its First Assessment Report in 1990, since when it has produced a number of update reports. Because it proved impossible to produce a Second Assessment Report in time for the first COP, the IPCC produced a special report covering some key topics. One of these is the latest scientific understanding of the factors that cause radiative forcing of climate change, which is the focus of this summary for policymakers. The document concludes that new findings since 1992 add to the detail of our knowledge of radiative forcing, but do not substantially change the essential results. Assessment of Global Warming Potentials (GWPs) for radiatively active compounds are updated. Compared with GWPs listed in the 1992 IPCC report most values are larger by typically 10-30 per cent. The policymakers' summary also estimates the level of carbon dioxide emissions that would be needed to achieve stabilization of atmospheric carbon dioxide emissions, which is an important goal of the climate change convention. The document concludes that stabilization at any level between one and two times today's concentration could be attained "only with global anthropogenic emissions that eventually drop to substantially below 1990 levels."

The other three documents that make up the IPCC special report prepared for the COP are: *IPCC Technical Guidelines for Assessing Climate*

A summary of key greenhouse gases affected by human activities

	CO ₂	CH ₄	N ₂ O	CFC-12	HCFC-22	CF ₄
Pre-industrial concentration	280 ppmv	700 ppbv	275 ppbv	zero	zero	zero
Concentration in 1992	355 ppmv	1714 ppbv	311 ppbv	503 pptv	105 pptv	70 pptv
Recent rate of concentration change per year (over 1980s)	1.5 ppmv/yr 0.4%/yr	13 ppbv/yr 0.8%/yr	0.75 ppbv/yr 0.25%/yr	18-20 pptv/yr 4%/yr	7-8 pptv/yr 7%/yr	1.1-1.3 pptv/yr 2%/yr
Atmospheric lifetime (years)	(50-200) ¹	(12-17) ²	120	102	13.3	50,000

* ppmv = parts per million by volume, ppbv = billion (10⁹), pptv = trillion (10¹²).

¹ No single lifetime for CO₂ can be defined because of the different rates of uptake by different sink processes.

² This has been defined as an adjustment time which takes into account the indirect effect of methane on its own lifetime.

Source: Radiative Forcing of Climate Change: The 1994 Report of the Scientific Assessment Working Group of IPCC – Summary for Policymakers

Change Impacts and Adaptations (reviewed below); *Evaluation of the IPCC IS92 Emission Scenarios*; and *IPCC Guidelines for National Greenhouse Gas Inventories*.

(1994). Intergovernmental Panel on Climate Change. Pbk, 28p. ♦

IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations

This is a companion document to that reviewed above and part of the special report by the Intergovernmental Panel on Climate Change (IPCC) to the first Conference of the Parties to the UN Framework Convention on Climate Change. The document updates and expands on preliminary guidelines produced by the IPCC in 1992; its aim is to provide a framework to enable estimation of climate change-related impacts and adaptations, allowing comparable assessments to be made for different regions, sectors and countries. The guidelines are intended to help Parties meet, in part, commitments under Article 4 of the Convention. Thus, the report does not estimate potential impacts of climate change, but sets out a method by which these can be studied including: definition of the problem, selection of a model, testing the method, selection of scenarios, assessment of impacts, and evaluation of adaptation strategies. Concurrently, UNEP is developing a set of workbooks, designed to translate the technical procedures described by the IPCC into practical methods of impact and adaptation assessment at the country and sectoral level.

(1994). Department of Geography, University College London, 26 Bedford Way, London WC1H 0AP, UK; and the Center for Global Environmental Research, National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305, Japan. Pbk, 59p. ISBN 0-904813-11-8. ♦

Urban Energy Handbook: Good Local Practice

Cities in OECD countries consume 60 to 80 per cent of total energy. This causes local pollution and contributes significantly to global environmental damage. This publication, based on more than 40 case studies, underlines the role cities may play in promoting less energy-intensive forms of urban development and management, provoking less environmental damage.

(1995). Organisation for Economic Co-operation and Development, 2 rue André-Pascal, 75775 Paris Cedex 16, France. Pbk, 230p. ISBN 92-64-14335-1. ♦

Global Climate Change: Science, Policy and Mitigation Strategies

This book contains the proceedings of a conference of the same title, organized by the Air & Waste Management Association and held on 5-8 April 1994 in Phoenix, Arizona. About 300 people from 23 countries participated at the conference in discussions on the science and

technology, policy, and mitigation aspects of climate change. Subjects addressed included: greenhouse gas emissions, climate modelling, the effects of greenhouse gases on ecological systems, assessments of social and economic impacts of climate change, mitigation strategies, and energy and environmental policies that could contribute to climate change mitigation.

C.V. Mathai and G. Stensland, eds (1994). Air & Waste Management Association, 1 Gateway Center, Third Floor, Pittsburgh, PA 15222, USA. Tel: +1 (412) 232 3444, Fax: 232 3450. Hbk, 1101p. ISBN 0-923204-11-3, \$95.00. ♦

European Community Energy Law: Selected Topics

This book arose out of summer courses held in 1992 by the Centre for Petroleum and Mineral Law and Policy at the University of Dundee, Scotland, which focused on the implications for energy industries of European integration and of recent changes to UK energy law. The book aims to act as a reference source for anyone interested in the European Union energy sector. Three out of 21 chapters focus specifically on environmental aspects.

D.S. MacDougall and T.W. Wälde, eds (1994). Graham & Trotman Ltd, Sterling House, 66 Wilton Road, London SW1V 1DE, UK. Hbk, 318p. ISBN 1-85333-962-8, £65.00/\$110.00. ♦

Three reports from UNEP OCA/PAC focus on climate change implications

In 1987, UNEP's Oceans and Coastal Areas Programme Activity Centre (OCA/PAC) launched a series of investigations into the implications of climate change in the 11 regions covered by the Regional Seas Programme. A number of studies have now been published under this programme

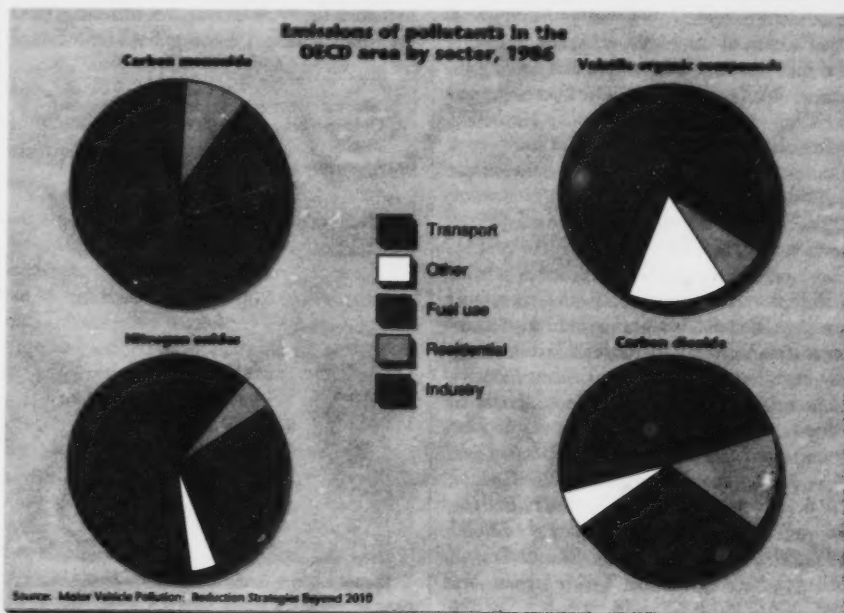
of work, including three new titles received by UNEP IE. Two of these assess the implications of climate change for specific geographical areas: the seas around west and central Africa, and the Gulf of Persia and Gulf of Oman. The third report assesses the implications of climate change for mangrove swamps, which are a particularly important coastal ecosystem in many tropical regions.

Implications of Expected Climate Change in the West and Central African Region: An Overview. A.C. Ibe and S.O. Ojo (1994). UNEP Regional Seas Reports and Studies No 148, Pbk, 42p. *Implications of Climate Change in the ROPME Region: An Overview*. E.M. Hassan and M.A. Gerges (1994). UNEP Regional Seas Reports and Studies No 155, Pbk, 25p. *Assessment and Monitoring of Climate Change Impacts on Mangrove Ecosystems*. (1994). UNEP Regional Seas Reports and Studies No 154, Pbk, 62p. All three titles are available from UNEP OCA/PAC, P.O. Box 30552, Nairobi, Kenya. ♦

CHEMICALS/POLLUTION

Motor Vehicle Pollution: Reduction Strategies Beyond 2010

"Motor vehicle use is now generally recognized as the source of more air pollution than any other single human activity," according to this Organisation for Economic Co-operation and Development (OECD) analysis of medium to long-term strategies for reducing road traffic pollution. In the OECD area, road transport is the dominant source of carbon monoxide, nitrogen oxides, volatile organic compounds, and a substantial, growing contributor to emissions of greenhouse gases such as carbon dioxide. Against a background of growing vehicle numbers and kilometres travel-



led, and stagnating fuel efficiency improvements, the OECD established a research programme aimed at exploring the full range of opportunities for reducing the air pollution caused by road transport. A number of detailed analyses have already been published under the programme, and these form the basis for this report. The report concludes that much more could be done to reduce motor vehicle pollution, and that "barriers to progress... are not primarily technical, but are largely related to deficiencies in current market and regulatory frameworks." The technological means to cleaner driving are far from exhausted. What is needed is committed action by governments, which should develop a comprehensive strategy "going beyond traditional forms of regulation" and emphasizing pollution prevention options. This last is seen as being the "decisive" factor, but also the most difficult to implement in practice because of "important" political and institutional barriers. The report shows clearly that, in the absence of determined action to curb it, motor vehicle pollution will rise substantially up to and beyond 2010, both in the OECD area and worldwide. On the basis of currently adopted policies, emissions of carbon monoxide, hydrocarbons and nitrogen oxides should fall in the OECD area to 2010, but are likely to rise again thereafter. However, carbon dioxide emissions could rise nearly 20 per cent between 1990 and 2010. Across the world, road-related carbon dioxide emissions could more than double by 2020, relative to 1990 levels.

(1995). *Organisation for Economic Co-operation and Development*, 2 rue André-Pascal, 75775 Paris Cedex 16, France. Pbk, 133p. ISBN 92-64-14312-2.

Industrial Chemicals: The Characteristics and Development

The world of industrial chemistry is described in detail in this book. Issues such as naming and classification of chemicals, safety, formulations and specifications, information and patents are treated. Process-related topics are discussed, such as scaling-up, equipment selection, construction materials, environmental impact and waste minimization. Aspects that fall in between the traditional disciplines of chemistry and chemical engineering are covered, being critical for the development of a successful industrial process. Case studies are given, and appendices provide useful information for the industrial chemist or student. The book is aimed at industrial chemists and engineers, and at students in those faculties intending to pursue this field in industry. Marketing and purchasing staff could also find it valuable.

Industrial Chemistry Library, Vol. 6, Giora Agam (1994). Elsevier Science B.V., P.O. Box 211, 1000 AE Amsterdam, the Netherlands. Hbk, 380p. ISBN 0-444-88887-X, Dfl 425.00, \$243.00. Also available from Elsevier Science, Inc., P.O. Box 945, Madison Square Station, New York, NY 10160-0757, USA.

The Dictionary of Substances and Their Effects

This massive dictionary has been compiled as a reference guide to the toxicological and environmental behaviour and effects of 5000 common or environmentally significant substances. It has been compiled by a substantially British team, with some international involvement. For each compound listed, the dictionary presents basic chemical and physical properties, occupational exposure limits, ecotoxicity, environmental fate, mammalian and avian toxicity, legislative controls, and important references in the scientific literature. The bulk of the information presented is globally applicable, though legislative information tends to be British. The publishers hope to release a CD-ROM version of the dictionary later in 1995.

M.L. Richardson and S. Gangolli, eds (1992/3/4). *The Royal Society of Chemistry*, Thomas Graham House, Science Park, Milton Road, Cambridge CB4 4WF, UK. Tel: +44 (1223) 420 066, Fax: 423 429, E-mail: rsc1@rsc.org. Hbk (seven volumes), 6200p. ISBN 0-85186-381-7, £1050. Individual volumes: Vols 1-5 £180.00, Vols 6-7 £220.00.

Mercury: Background and National Experience with Reducing Risk

This title is the fourth in the Organisation for Economic Co-operation and Development (OECD) Risk Reduction Monograph series. Other titles in the series have covered risk reduction for lead, methylene chloride, selected brominated flame retardants, and cadmium. Each monograph describes the commercial life cycle of the chemical or group of chemicals in question, the environmental life cycle, risk reduction and control measures, and international and national positions on the perceived risk. OECD Member countries have taken a number of risk reduction measures for mercury, including: bans on mercury in seed dressing; bans on mercury

use in paint; guidelines or standards on the mercury content of food or fish; national or regional databases on environmental mercury levels; and, in a few cases, general bans on the use of mercury, with exemptions.

Risk Reduction Monograph No. 4, (1994). *Organisation for Economic Co-operation and Development*, 2 rue André-Pascal, 75775 Paris, Cedex 16, France. Fax: +33 (1) 45 24 16 75. Pbk, 157p. Ref: OCDE/GD(94)98. Available free of charge, in limited quantities, from the OECD Environment Directorate, Environmental Health and Safety Division at the address above. Fax: +33 (1) 45 24 16 75.

Destruction of Hazardous Chemicals in the Laboratory

Like its predecessor, published in 1990, this book contains a collection of detailed procedures that can be used to degrade and dispose of a wide variety of hazardous chemicals. The book has been expanded and updated to broaden the scope of chemicals treated and to include new and modified procedures and alternatives to the use of some highly toxic materials. New chapters have been added on the removal of metal ions and biological stains from solution and the degradation of mycotoxins, enzyme inhibitors, polycyclic heterocyclic hydrocarbons, and highly reactive reagents such as butyllithium, chlorosulphonic acid, peracids, and phosgene. Another new chapter covers the alternatives to complex metal hydrides in the preparation of super-dry solvents. An appendix describes new technologies for the treatment of complex waste streams produced by biomedical research institutions.

2nd edition, George Lunn & Eric B. Sansone (1994). John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012, USA. Hbk, 499p. ISBN 0-471-57399-X.

Computer Simulation

This book and the following one contain the papers presented at the Second International Air Pollution Conference, held in Barcelona, Spain on 27-29 September 1994. The conference was organized by the Wessex Institute of Technology, Southampton, UK, and the Universitat Politècnica de Catalunya, Barcelona, Spain. The objective was to bring together scientists from industry, research organizations, government and academia who work on monitoring, simulation and management of air pollution. The emphasis was on the development of experimental and computational techniques, which can be used as tools for the solution and understanding of air pollution problems. These tools can be used to evaluate proposed emissions control techniques and strategies, or for forecasting air pollution episodes. Volume 1 contains papers presented on: meteorological modelling, turbulence and diffusion modelling, chemical transformation, urban case studies and pollution engineering.

Air Pollution II, Volume 1, J.M. Baldasano and others, eds (1994). *Computational Mechanics*

Mercury emissions in the European Community from product use, 1989

tonnes/year	Air ¹	Water	Land	Total
Batteries	33	<1	100	133
Dental amalgams	8	14	24	46
Electrical lighting and equipment	10	<1	30	40
Measuring and control instruments	6	<1	19	25
Laboratory applications	1	1	6	8
Phosphate fertilizers	7	7	11	11
Industrial catalyst	4	<1	12	16
Total	62	17	202	281

¹ From municipal solid waste incineration. Only 8 per cent of incinerators have gas-cleaning technology.

Source: Mercury: Background and National Experience with Reducing Risk

Publications, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK. Tel: +44 (1703) 293 223, Fax: 292 853, E-mail: CMI@ib.rl.ac.uk. For USA, Canada and Mexico: Computational Mechanics, Inc., 25 Bridge Street, Billerica, MA 01821, USA. Tel: +1 (508) 667 5841, Fax: 667 7582, E-mail: CMINA@com.netcom. Hbk, 590p. ISBN 1-85312-360-9 (Southampton), 1-56252-284-1 (Billerica). ♦

Pollution Control and Monitoring

Volume 2 in the series (see review above) contains papers presented on global studies, emission inventory and modelling, data analysis and observation, monitoring and laboratory studies, and pollution control and management.

Air Pollution II, Volume 2, J. M. Baldasano and others, eds (1994). *Computational Mechanics* (see contact details in review above). Hbk, 560p. ISBN 1-85312-361-7 (Southampton), 1-56252-285-X (Billerica). ♦

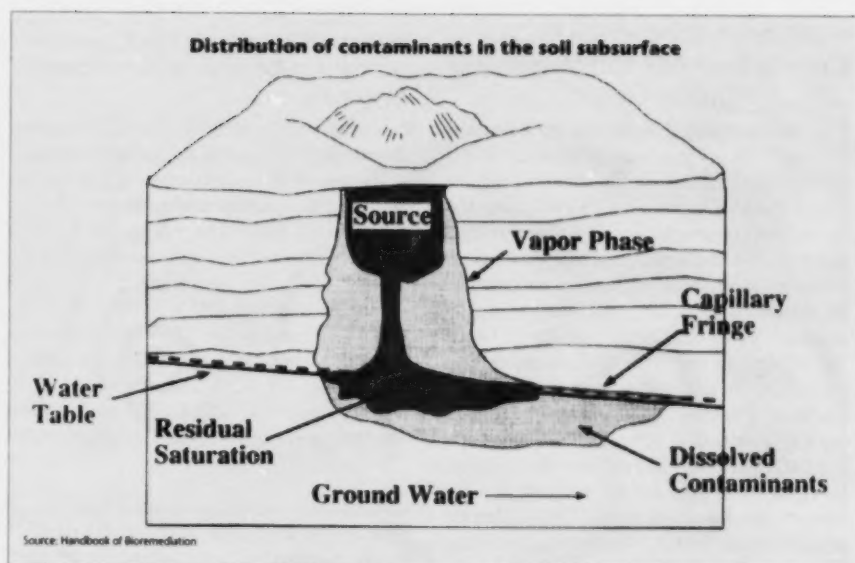
Dioxin and its Analogues

Published in English translation in March 1995, this 1994 publication of the French Academy of Sciences reviews the environmental and health risks of dioxins, including patterns of exposure and control measures taken in developed countries. Dioxin is the common name for a group of halogenated polycyclic organic compounds called polychlorodibenzodioxins (PCDDs) and polychlorodibenzofurans (PCDFs). These chemicals are thought to be highly toxic, though both the mechanisms of their toxicological activity and the degree of risk they pose have long been sources of controversy. *Dioxin and its Analogues* reviews the main strands of evidence collected by studies of human exposure to dioxins. The book also looks at trends in exposure, noting that atmospheric emissions of dioxins are today declining. Amongst remaining sources of exposure, waste incineration is picked out as an area requiring close attention, especially given the larger role forecast for incineration in future waste management policies.

(1994). *Technique & Documentation - Lavoisier*, 11 rue Lavoisier, F 75384 Paris, Cedex 08, France. Tel: +33 (1) 47 40 67 63, Fax: 47 40 67 02. English translation: Pbk, 109p. ISBN 2-7430-0020-1, ISSN 1159-7410. ♦

Guidance Document for Aquatic Effects Assessment

The Organisation for Economic Co-operation and Development (OECD) Environment Monograph series is designed to make selected technical reports prepared by the OECD Environment Directorate available to a wide readership. This title in the series is intended to integrate previous OECD work on the assessment of aquatic effects of chemicals and pesticides - namely, the application of Quantitative Structure Activity Relationships (QSARs) to toxicity data (see reviews in *Industry and Envi-*



ronment, Vol. 16, N° 4, pp. 63-64 and Vol. 17, N° 2, p. 65); the extrapolation of laboratory data to the real environment; and the effects of chemicals on sediments - into a scheme for aquatic risk assessment of new and existing chemicals. The document describes how to use information on the toxicity of a chemical to derive a Maximum Tolerable Concentration (MTC) in water. Methods for deriving an MTC where the available data set is limited are described, including the use of QSARs where laboratory data are missing. Several methods of extrapolating from a limited range of observations on test species to derive a general MTC are also described. The monograph also deals with hazards related to secondary poisoning due to bioaccumulation of toxic substances in the aquatic ecosystem.

OECD Environment Monograph Series N° 92 (1994). Organisation for Economic Co-operation and Development, 2 rue André-Pascal, 75775 Paris Cedex 16, France. Pbk, 116p. Ref: OCDE/GD (95)18. Available free of charge, in limited quantities, from the OECD Environment Directorate, Environmental Health and Safety Division at the address above. Fax: +33 (1) 45 24 16 75. ♦

Handbook of Bioremediation

The *Handbook of Bioremediation* has been prepared by experts at a laboratory of the US Environmental Protection Agency that specializes in investigating the soil and subsurface environment. The handbook aims to provide a detailed background of the technologies available for the bioremediation of contaminated soil and groundwater, focusing on contamination by petroleum hydrocarbons and chlorinated solvents. After introducing the principles of bioremediation, the handbook describes the processes, applications and limitations of various bioremediation technologies, including bioventing, air sparging, alternate electron acceptors, and the use of microorganisms.

R.D. Norris and others (1994). CRC Press, Inc., 2000 Corporate Boulevard, N.W., Boca Raton,

Florida 33431, USA. Hbk, 257p. ISBN 1-56670-074-4. \$73.50. Also available from Times Mirror International Publishers Ltd, Unit 1, 3 Sheldon Way, Larkfield, Aylesford ME20 6SF, UK, at £49.00. ♦

Bioremediation of Hazardous Wastes

This document, published in the US Environmental Protection Agency (EPA) Research Series, is a compilation of three documents on hazardous waste remediation. Part one contains papers presented at a symposium on bioremediation held in Chicago, Illinois in May 1992. Part two is an issue of an EPA newsletter, *Ground Water Issue*, published in February 1992, which provides an overview of the factors involved in *in situ* bioremediation of contaminated groundwater. Part three is from the August 1993 issue of *Bioremediation in the Field*, an EPA information update on new developments in bioremediation at hazardous waste sites.

(1994). Government Institutes, Inc., 4 Research Place, Suite 200, Rockville, Maryland 20850, USA. Tel: +1 (301) 921 2300. Pbk, 173p. ISBN 0-86587-388-7. ♦

Bioremediation of Groundwater and Geological Material: A Review of In Situ Technologies

This document was prepared under the supervision of the US Environmental Protection Agency (EPA), and is intended to provide the reader with a detailed background on the technologies available for the bioremediation of contaminated soil and groundwater. Various approaches to remediation are described, with a focus on pollution by petroleum hydrocarbons and chlorinated solvents.

(1994). Government Institutes, Inc., 4 Research Place, Suite 200, Rockville, Maryland 20850, USA. Tel: +1 (301) 921 2300. Pbk, 173p. ISBN 0-86587-404-2. ♦

News

IPCS Environmental Health Criteria booklets and Health and Safety Guides

The International Programme on Chemical Safety (IPCS) is a joint venture between UNEP, the International Labour Organisation and the World Health Organization (WHO). Booklets in the Environmental Health Criteria (EHC) series review the environmental and health effects of exposure to a chemical or group of chemicals and provide guidelines for setting exposure limits. The Health and Safety Guide (HSG) series facilitates the applications of these guidelines in national chemical safety programmes. The booklets are in English (those in the EHC series have summaries in French and Spanish). They are priced in Swiss francs (shown here), or US dollars, and are available at a discount in developing countries. The booklets are available from WHO, Distribution and Sales, CH-1211 Geneva 27, Switzerland, and from sales agents for WHO. The latest titles in the series are:

EHC 162 – Brominated Diphenyl Ethers (1994). Pbk, 347p. ISBN 92-4-157162-4, SF 47.00/SF 32.90 in developing countries.

EHC 170 – Assessing Human Health Risks of Chemicals: Derivation of Guidance Values for Health-based Exposure Limits (1994). Pbk, 73p. ISBN 92-4-157170-5, SF 16.00/SF 11.20 in developing countries. ♦

NATIONAL/REGIONAL

The Chemical Industry in India and Some Facts about Gujarat

This is one of a series of Working Papers produced by the Department of Human Geography and the Centre for Development and the Environment, both at the University of Oslo. The objective of the series is to document and explain changes in the international location of pollution-intensive industry, and to discuss these changes in the context of sustainable development in poor countries. The Working Paper describes the growth and involvement of transnational companies in the chemical and allied industries in India, highlighting cases of occupational hazards and pollution. Indian industrial policies and environmental laws and regulations are also discussed. The paper then looks in more detail at the chemical industry in Gujarat, which is one of the most heavily industrialized states in India.

FIL Working Paper N° 4, Radha D'Souza (1994). Forurendsende Industri-Lokalisering (FIL), Department of Human Geography, University of Oslo, PB 1056, Blindern, 0316 Oslo, Norway. Fax: +47 (2) 285 4828, E-mail: jan.hesselberg@sgeo.uio.no. Pbk, 92p. ISSN 0804-5828. ♦

Industrial Pollution: The Chemical Industry in Gujarat, India: Research Proposals

Part of the same series as the title reviewed above, this Working Paper documents instances of transfer of pollution-intensive production from North to South, and considers whether transnational companies operate with lower technological standards in the South than in the North.

FIL Working Paper N° 5, Jan Hesselberg, ed. (1995). Forurendsende Industri-Lokalisering (FIL), Department of Human Geography, University of Oslo, PB 1056, Blindern, 0316 Oslo, Norway. Fax: +47 (2) 285 4828, E-mail: jan.hesselberg@sgeo.uio.no. Pbk, 95p. ISSN 0804-5828. ♦

The Legal Process and Limits of Environmental Legislation in India

Part of the FIL series of Working Papers focusing on the possible transfer of polluting industries from North to South, this booklet describes environmental law and regulations in India, commenting on the strengths and weaknesses of different laws and their implementation.

FIL Working Paper N° 7, Radha D'Souza (1995). Forurendsende Industri-Lokalisering (FIL), Department of Human Geography, University of Oslo, PB 1056, Blindern, 0316 Oslo, Norway. Fax: +47 (2) 285 4828, E-mail: jan.hesselberg@sgeo.uio.no. Pbk, 91p. ISSN 0804-5828. ♦

INDUSTRY SECTORS

Development, Environment and Mining: Enhancing the Contribution of the Mineral Industry to Sustainable Development

This short booklet reports on the outcome of the International Conference on Development, Environment and Mining, held in Washington, DC on 1-3 June 1994. The conference was co-sponsored by UNEP, the UN Conference on Trade and Development, and the International Council on Metals and the Environment (ICME). The objective of the conference was to further public debate on environment and development issues relevant to mining, including not only its negative impacts but also the benefits it can bring. One of the conclusions drawn from the conference by its President was that "principles of environmental management are being adopted and the [mining] industry is making rapid progress... The management systems being adopted depend on regulations and on corporate cultures. These systems are part of the industry's efforts to demonstrate that mining is compatible with environmental protection."

(1994). *International Council on Metals and*

the Environment, 360 Albert Street, Suite 1550, Ottawa, Canada K1R 7X7. Tel: +1 (613) 235 4263, Fax: 235 2865. Pbk, 24p. Available free of charge. ♦

Decommissioning of Facilities for Mining and Milling of Radioactive Ores and Closeout of Residues

Mining and milling of radioactive ores result in contaminated buildings and facilities that should be decommissioned, as well as large quantities of tailings and other residues that should be managed safely. During the 1980s, many uranium mines and mills were closed. More are being closed as uranium production becomes unprofitable because of lower prices resulting from a decrease in demand and an abundant supply. The purpose of this report is to provide guidance to International Atomic Energy Agency Member States in order to assist in planning and implementing the decommissioning of uranium mines and mills, including tailings impoundments, mining debris piles, leach residues and unprocessed ore stockpiles.

Technical Reports Series N° 362, (1994). International Atomic Energy Agency, Wagramstrasse 5, P.O. Box 100, A-1400 Vienna, Austria. Pbk, 186p. ISBN 92-0-100694-2, ISSN 0074-1914. ♦

Biofertiliser Technology, Marketing and Usage: A Sourcebook-cum-Glossary

Biofertilizers are microorganisms that either fix atmospheric nitrogen or enhance the solubility of soil nutrients, improving the growth rates of crops. This book examines the development and use of biofertilizers from an Indian perspective, concentrating on *Rhizobium*, but also covering *Azotobacter*, *Azospirillum*, blue-green algae, azolla, phosphate solubilizing microorganisms and mycorrhizae. The book describes practical steps necessary for the use of biofertilizers, including equipment and raw materials, selection of strain, biofertilizer production technology, marketing of biofertilizers, and biofertilizer application technology.

M.R. Mutsara, P. Bhattacharyya and B. Srivastava (1995). Fertiliser Developments and Consultation Organisation, 204 Bhanot Corner, 1-2 Pamposh Enclave, New Delhi 110048, India. Tel: +91 (11) 641 7801, Fax: 646 5645. Hbk, 184p. ISBN 81-85116-38-5, Rs. 300 in India, \$60.00 outside India. ♦

Analysis of Information Elements Used in the Assessment of Certain Products of Modern Biotechnology

The Organisation for Economic Co-operation and Development (OECD) Environment Monograph series is designed to make selected technical reports prepared by the OECD Environment Directorate available to a wide readership. This title in the series focuses on

regulations in OECD Member countries on applications of modern biotechnology that involve living organisms intended to be released to the environment. Industrial examples include bioremediation of contaminated land, bio-leaching of minerals and biomining. The Monograph concludes that over 65 per cent of the information required in Member countries in the context of these applications of biotechnology by regulatory agencies is already similar, indicating a strong basis for exploring common information and data collection methods.

OECD Environmental Monograph Series N° 100 (1994). Organisation for Economic Co-operation and Development, 2 rue André-Pascal, 75775 Paris Cedex 16, France. Pbk, 40p. Ref: OCDE/GD(94)95. Available free of charge, in limited quantities, from the OECD Environment Directorate, Environmental Health and Safety Division at the address above. Fax: +33 (1) 45 24 1675.

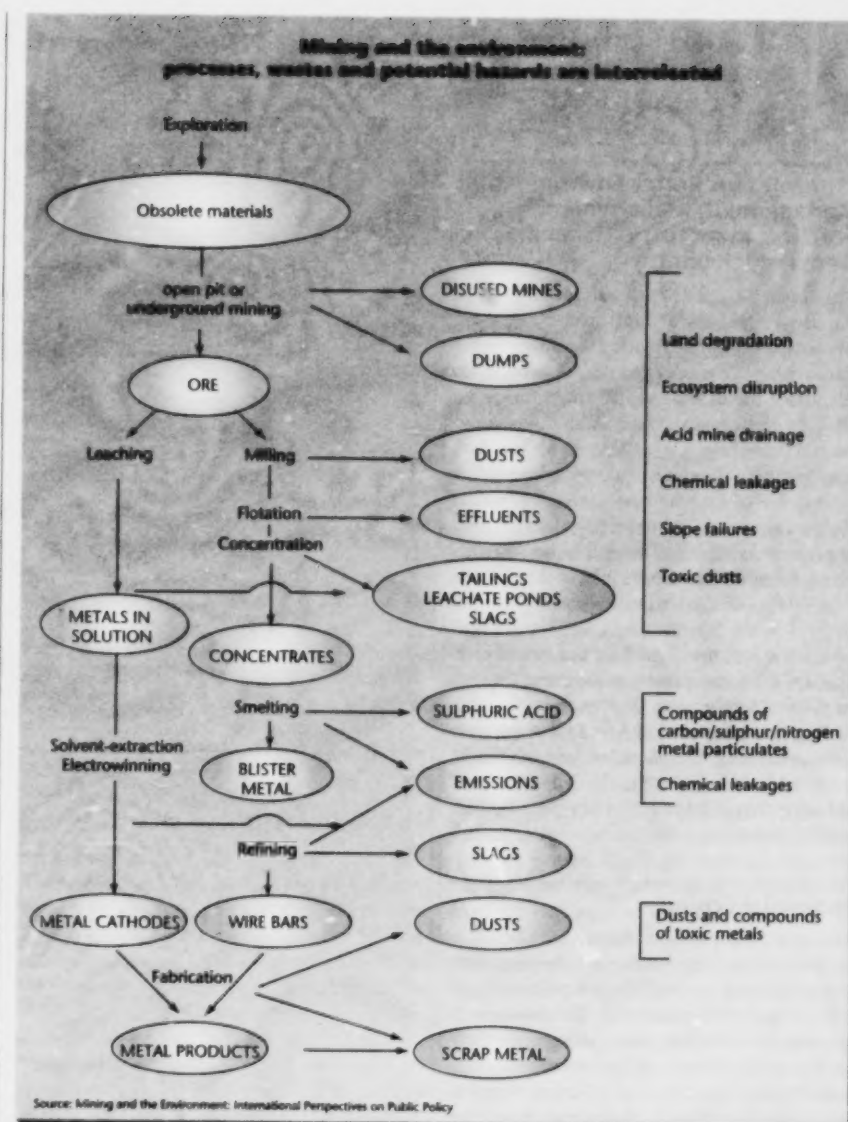
Mining and the Environment: International Perspectives on Public Policy

For centuries, denuded landscapes, fouled streams and dirty air were accepted by society as part of the price that had to be paid for mineral production. Even initial environmental legislation devised by industrialized countries in the 1960s and 1970s was largely designed without mining in mind. And developing countries had little in the way of environmental policy. With the advent of the sustainability concept in the 1990s, times have changed. Today's economic development, many now feel, must not come at the expense of an environmentally degraded future. Current policies towards mining are under rigorous review, and mineral-rich developing countries are designing environmental policies where none existed before. The mining industry is more concerned than it was even five or ten years ago about the possible effects of environmental policy on its activities. In *Mining and the Environment*, analysts offer viewpoints from Australia, Chile, the US and the European Union on issues and challenges this new concern has raised for metal mining.

Roderick G. Eggert, ed. (1994). *Resources for the Future*, 1616 P Street, N.W., Washington, D.C. 20036-1400, USA. Pbk, 172p. ISBN 0-915777-72-1.

Recycling of Crop, Animal, Human and Industrial Wastes in Agriculture

A "sizable proportion" of the nutrient needs of agriculture, horticulture, forestry and aquaculture can be met through recycling of wastes and by-products, according to this book. The book aims to bring recycling know-how into the mainstream of agricultural planning and management. In addition to various agricultural and human wastes, the book describes the reuse of some industrial wastes in agriculture. One of



these is sugar factory press-mud, or filter cake, which can be used as a fertilizer, an ameliorant for acidic or saline soils, as a medium for raising sugarcane seedlings, or as a carrier for legume inoculants. Another industrial waste for which uses can be found in agriculture is basic slag from iron blast furnaces, as a phosphate fertilizer and liming material.

H.L.S. Tandon, ed. (1995). *Fertiliser Development and Consultation Organisation*, 204 Bhanot Corner, 1-2 Pamposh Enclave, New Delhi 110048, India. Tel: +91 (11) 641 7801, Fax: 646 5645. Hbk, 150p. ISBN 81-85116-37-7, Rs. 240 in India, \$60.00 outside India

Stirring Up Innovation: Environmental Improvements in Paints and Adhesives

Stirring Up Innovation examines the process of environmental change in the US paints and adhesives industry, with the aim of providing US citizens' groups with the information necessary

to lobby for environmental improvements in paint or adhesive manufacturing companies in their own localities. The book introduces environmental issues associated with paints and adhesives and describes the relevant US environmental regulations. It reviews environmental initiatives undertaken by seven companies operating in the sector, asking a number of questions of each: what did it see as the perceived dangers of continuing to do business as usual? what motivated innovation? what hurdles had to be surmounted? and what regulations affected progress? The book focuses on product management and environmental improvement. It does not address broader questions of sustainable commerce, such as whether all uses of these products are necessary.

John S. Young, Linda Ambrose and Lois Lobo (1994). *Inform, Inc.*, 120 Wall Street, New York, NY 10005-4001, USA. Tel: +1 (212) 361 2400, Fax: 361 2412. Pbk, 116p. ISBN 0-918780-63-2.

INDUSTRIAL ENVIRONMENTAL MANAGEMENT

Principles for Better Environmental Management: Management Practices in Industry – Examples from French Industry

This book describes corporate experience in improved environmental management of member companies of the French association, *Entreprises pour l'Environnement*. Its aim is to encourage the widest possible commitment on the part of the business community to environmental protection. Only this commitment will lead to the development of a competitive industry capable of creating new jobs and resources for the country, whilst respecting the vital need to preserve its natural heritage. The book's structure is based on the 16 principles of the Business Charter for Sustainable Development, produced in 1991 by the International Chamber of Commerce. Case studies of good environmental practice in French companies are presented for each of these principles.

Patrick Nollet, ed. (1994). *Entreprises pour l'Environnement*, 5 Esplanade Charles de Gaulle, 92733 Nanterre Cedex, France. Tel: +33 (1) 47 24 64 55, Fax: 47 24 61 77. Pbk, 191p. ISBN 2-9508030-1-6.

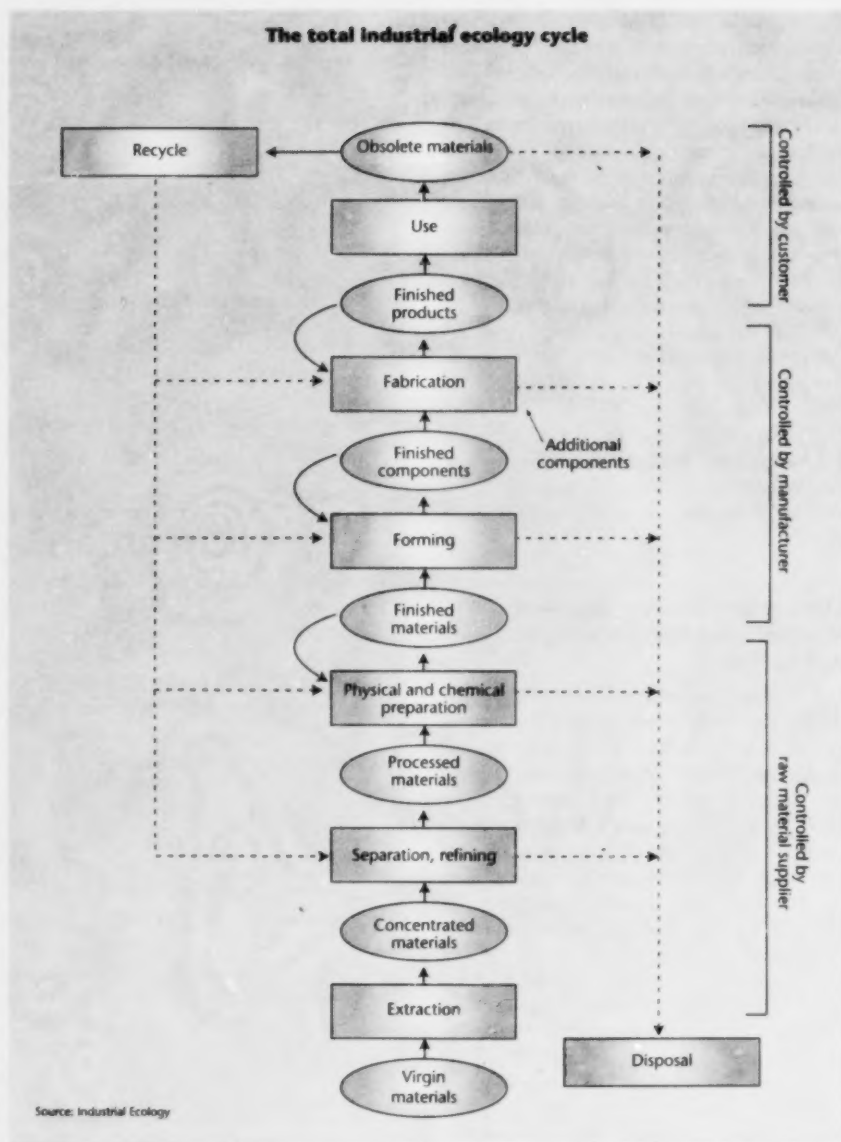
Industrial Ecology

Industrial ecology, like biological ecology, has as its focus the cycling of resources rather than their extraction and eventual discard following use. Achievement of sustainable development is dependent on attaining such cycling in the global economy, and industry and governments are turning from "end-of-pipe" pollution control to more holistic approaches involving an attempt to design pollution out of products rather than cleaning it up afterwards. This book is an introduction to the rapidly evolving field of industrial ecology. Topics covered include: cycling in the environment and the economy; design for recycling; environmental interactions during product use; designing for energy efficiency; the life-cycle approach and life-cycle analysis; and minimization of industrial residuals.

T.E. Graedel and B.R. Allenby (1995). Prentice Hall, Englewood Cliffs, New Jersey 07632, USA. Hbk, 412p. ISBN 0-13-125238-0.

A Primer on Responsible Care and Sustainable Development

First developed in Canada in the 1980s, the chemical industry's voluntary programme of environmental commitment and improvement – Responsible Care – is now in operation in many countries. This booklet sketches some of the links between the Responsible Care Programme and 18 "common themes" of sustainable development, describing actions taken by



members of the Canadian Chemical Producers' Association to respond to these. Amongst the themes highlighted are integrating environment into business planning, the precautionary principle, full-cost accounting, pollution prevention, waste minimization, emergency preparedness, product stewardship, and reporting to stakeholders and the public.

(1994). *The Canadian Chemical Producers' Association*, Suite 805, 350 Sparks Street, Ottawa, Ontario, Canada K1R 7S8. Fax: +1 (613) 237 4061. Pbk, 33p. Aussi disponible en Français.

Environmental Science and Technology Handbook

This book takes an encyclopedic approach to scientific, technological and regulatory aspects (in the US) of industrial environmental management, with chapters on the following topics: environmental processes; human health risk assessment; ecological risk assessment; environ-

mental chemistry and analysis of regulated compounds; air quality; air pollution control technologies; solid and hazardous waste treatment and disposal; storage tank technology; groundwater hydrology and pollution control; and pollution prevention through total quality management.

Kenneth W. Ayers and others (1994). *Government Institutes, Inc.*, 4 Research Place, Suite 200, Rockville, Maryland 20850, USA. Tel: +1 (301) 921 2300. Hbk, 389p. ISBN 0-86587-362-3.

Risk Assessment: Principles and Applications for Hazardous Waste and Related Sites

Site-specific risk assessment is the process of evaluating whether or not a site poses a risk to human health or the environment. The purpose of all hazardous waste site remediation is ultimately to render a site safe for human or ecological populations. Consequently, risk assessment, as the process used to measure the effectiveness

of the remediation process, is critical to all hazardous waste-site work. Risk assessment at hazardous waste sites involves the use of standard approaches and assumptions in a reasoned, common sense manner. The purpose of this book is to provide practical guidance to people wishing to learn about, conduct, or use risk assessment procedures in evaluating hazardous waste sites. Critical issues, standard formulas and assumptions, and guidance on characterizing risk results in a useable manner are presented. The use of risk assessment as a key tool in selecting appropriate remedial options at hazardous waste sites is also described. Most attention is given to human health risks associated with exposure to toxic chemicals, but descriptions of the strategies used to estimate radiation health risk and to evaluate risks to the environment are also provided. Although most commonly applied to hazardous waste site remediation, the procedures outlined are generally applicable to any situation involving a potential for health risks to an exposed population.

Peter K. Lagoy (1994). *Noyes Publications*, 120 Mill Road, Park Ridge, NJ 07656, USA. Hbk, 248p. 0-8155-1349-6, \$48.00. ♦

Controlling the Controllable: The Management of Safety

Improving a company's quality of management in order to prevent risks and accidents has become an issue of major interest and research in recent years. Accidents like Piper Alpha, Chernobyl and Exxon Valdez sent shock waves through the world of safety. Many companies have wondered what safety measures will have to be taken to avoid future calamities. Vast amounts of time, money and resources have been invested in improving the safety of industrial complexes. A further reduction of the number of accidents only seems possible if the problem of human error is tackled systematically. A theoretical framework developed by researchers at Leiden and Manchester universities (the Netherlands and the UK respectively) provides ways of relating the safety state of a company directly to measures for improving safety. Eleven mechanisms – general failure types – contributing to accident causation have been identified, ranging from the quality of hardware to the quality of the lines of communication. They constitute a list of controllable and quantifiable targets for measurement and improvement of a company's safety management or the quality of management in general. Seemingly obvious solutions, such as improving safety awareness, improving motivation, introduction of "unsafe act auditing" or removal of employees involved in accidents are aimed at trying to control those parts in the accident causation process that are actually controllable. This general failure types list serves as an instrument for more efficient allocation of a company's limited financial and human resources.

2nd edition, Jop Groeneweg (1994). *DSWO Press*, Leiden University, P.O. Box 9555, 2300 RB

Criteria influencing public perception of risk		
Criteria	Characteristics perceived as:	
	Lower risk	Higher risk
Origin	natural	man-made
Volition	voluntary	involuntary
Effect manifestation	immediate	delayed
Severity (N° of people affected per incident)	ordinary	catastrophic
Controllability	controllable	uncontrollable
Benefit	clear	unclear
Familiarity of risk	familiar	unfamiliar
Exposure	continuous	occasional
Necessity	necessary	luxury
Effects on children	not at risk	at risk
Victim identity	"faceless statistics"	identifiable victims
Reversibility of effects	reversible	irreversible
Uncertainty	scientifically known	scientifically unknown
Trust in institutions	trust	lack of trust
Equity of risks and benefits	equitable	inequitable

Source: Controlling the Controllable: The Management of Safety

Leiden, the Netherlands. Tel: +31 (71) 273 600, Fax: 273 619. Pbk, 258p. ISBN 90-6695-106-0, Dfl 42.50. ♦

Workshop on Environmental Impact Assessment with Particular Focus on International Cooperation

The workshop referred to in the title of this document was organized by the UNEP Environment and Economics Unit and held in Nairobi on 5-7 September 1994. The workshop's aim was to identify gaps in international cooperation concerning environmental impact assessment (EIA) in developing countries and countries in transition to a market economy, particularly in the context of EIAs supported by international development assistance organizations. Amongst the meeting's conclusions was a consensus that enforcement of EIAs and environmental compliance required special attention as it was lacking in most countries. Participants also agreed that there was a need to strengthen national EIA procedures, and that methodologies were needed for the integration of EIA into wider development planning, especially relating to activities with major environmental impacts.

Environmental Economics Series, N° 13, Hussein Abaza (1994). *UNEP Environment and Economics Unit*, P.O. Box 30552, Nairobi, Kenya. Pbk, 53p. ♦

Design for the Environment: Product Life-Cycle Design Guidance Manual

This document seeks to promote the reduction of environmental impacts and health risks through a systems approach to design. The approach is based on the product life-cycle, which includes raw materials acquisition and processing, manufacturing, use-service, resource

recovery and disposal. A life-cycle design framework is presented to provide guidance for more effectively conserving resources and energy, preventing pollution, and reducing the aggregate environmental impacts and health risks associated with a product system. This framework addresses the product, process, distribution and management/information components of each product system. Concepts such as concurrent design, cross-disciplinary teams, multi-objective decision making, and total cost assessment are essential elements of the framework. Life-cycle design emphasizes integrating environmental requirements into the earliest phases of design and successfully balancing these requirements with all other necessary performance, cost, cultural and legal criteria. A multi-layer requirements matrix is proposed to assist design teams in identifying design requirements and resolving conflicts between them. Design strategies for meeting environmental requirements are then provided. Finally, environmental analysis tools and life-cycle accounting methods are presented for evaluating design alternatives.

(1994). *Government Institutes, Inc.*, 4 Research Place, Suite 200, Rockville, Maryland 20850, USA. Tel: +1 (301) 921 2300. Pbk, 179p. ISBN 0-86587-384-4. ♦

Environmental Audits

This edition of *Environmental Audits* has been substantially revised and updated. It has been reorganized into three parts: managing a programme, conducting an audit, and special topics. Highlights of the book include: regulatory growth and enforcement data; a discussion of emerging professional associations and registration programmes; a chapter on audit report writing; a chapter on typical problems faced by auditors; a discussion of property transfer audits; a chapter on waste minimization audits; and a discussion of management system audits.

News

6th edition, Lawrence B. Cahill & Raymond W. Kane (1989). *Government Institutes Inc.*, 4 Research Place, Suite 200, Rockville, Maryland 20850, USA. Tel: +1 (301) 921 2300. Pbk, 551p. ISBN 0-86587-776-9. ♦

TECHNOLOGY/SERVICES

Technology for a Sustainable Future: A Framework for Action

This interagency report outlines possible strategies and policies that the US Federal Government could take to advance the development and diffusion of environmental technologies, with the twin aims of boosting economic growth and ensuring a cleaner environment. The report is guided by four principles for environmental technology development: the need to shift from control technologies and waste management to pollution avoidance and resource conservation; the need to stimulate the development of environmental technologies; the desirability of increasing the market share held by the US in the global environmental technologies market; and the importance of partnerships between public and private bodies, and of education. The report is intended as a starting point for a broad-ranging public debate in the US, leading to development of a national environmental technology strategy that fosters the integration of federal, state and private efforts.

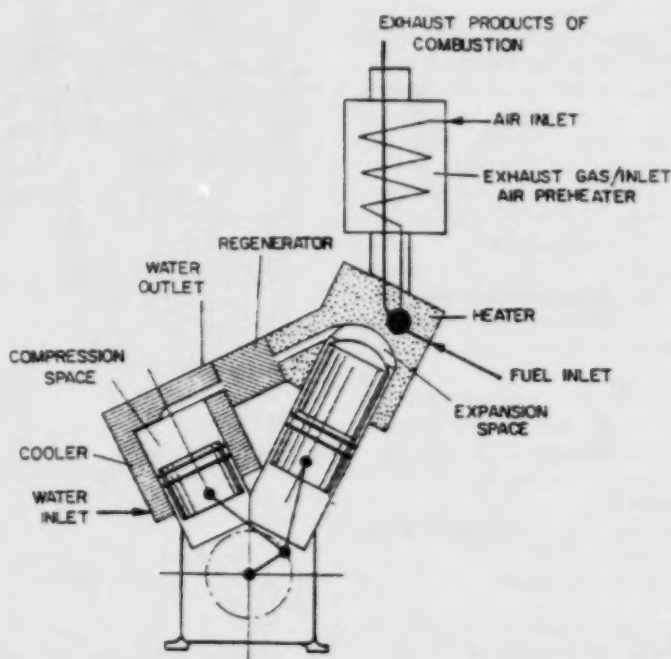
(1994). *Office of Science and Technology Policy*, Room 443, Old Executive Office Building, Washington, DC 20500. Pbk, 154p. US Government Printing Office ref: 386-802/00037. ♦

Separation Technology: The Next Ten Years

Separation technology is at the heart of engineering in the chemical and process industries. This book takes the pulse of the technology, and assesses its health for future use. Recently, separation technology has been under pressure to improve both the quality and diversity of products. In response, the conditions of older technologies – drying, crystallization and distillation – have been improved, whilst newer ideas like adsorption and bio-separations have been brought rapidly into training. Understanding the underlying phenomena of separations, argue the authors, leads to better equipment design and more applications. Newer processes depend on subtle differences in the molecular architecture of the components to be separated: chiral molecules, for example. The way in which this is reflected on a larger scale is one of the themes of the book.

John Garside, ed. (1994). *Institution of Chemical Engineers*, Davis Building, 165-189 Railway Terrace, Rugby CV21 3HQ, UK. Tel: +44 (1788) 578 214, Fax: 560 833. Telex: 311780. Pbk, 174p. ISBN 0-85295-339-9. ♦

A practical opposed-piston Stirling engine



Source: *The Stirling Alternative: Power Systems, Refrigerants and Heat Pumps*

The Stirling Alternative: Power Systems, Refrigerants and Heat Pumps

Stirling machines are a form of heat engine depending for their operation on the expansion and compression at different temperatures of a gaseous working fluid. They incorporate a novel component, a form of heat exchanger acting as a thermodynamic sponge, which makes Stirling engines uniquely efficient forms of heat engines. Named after their inventor, Robert Stirling, Stirling engines have been known for more than 150 years, but have never achieved widespread use. Now they appear poised for large-scale employment, according to *The Stirling Alternative*, "to help resolve some of humanity's concerns with energy usage, conservation and environmental protection." The book aims to introduce Stirling engines to newcomers to the field, and to be a handbook for those already familiar with them. It describes the history, essential technology and applications of Stirling engines, provides a survey of Stirling engine literature, and evaluates future prospects.

Graham Walker and others (1994). *Gordon and Breach Science Publishers*, Y-Parc, Chemin de la Sallaz, 1400 Yverdon, Switzerland. Hbk, 237p. ISBN 2-88124-600-1. ♦

Safety Management Systems

The majority of accidents in the process industries, this book emphasizes, can be traced back to bad management. Set up a system to manage

safety competently, and you are most of the way to safe operation. After a preamble on the key characteristics of safety management systems, the book gives practical details of how six major European chemical manufacturers organize their safety management programmes. This is intended to provide guidance to large, medium and small companies, which may not have the resources to plan their own management of safety entirely independently. The book was compiled by the European Process Safety Centre, an international, industry-funded organization that exists to provide an independent technical focus for technical safety in Europe. It is a cooperative project, administered by the Institution of Chemical Engineers on behalf of the European Federation of Chemical Engineering.

(1994). *Institution of Chemical Engineers* (contact details above). Pbk, 45p. ISBN 0-85295-356-9. ♦

Process Utility Systems: Introduction to Design, Operation and Maintenance

Most engineers need, at some stage in their careers, to know more about utility systems than they learned during their basic training. Every industrial plant depends for its operation on the provision of utilities – fuel, water, compressed air, inert gases, heating, cooling, ventilation, and so on. Utilities play a vital role in industrial operations. Seventy per cent of the energy used on a typical chemical industry site passes through the utility systems. And energy wastage, like other

inefficiencies in the operation of utility systems, contributes to environmental pollution. This book puts the subject of utility systems on a firm engineering base. It considers the basics – the nature, uses and costs of the various utilities – and then goes into detail. It deals with the distribution systems that bring utilities to the site and to their points of use, and the ways in which utilities can be integrated both with the production processes on site and with each other. The book's aim is to serve as an introduction for beginners and as a memory-jogger for the experienced.

Jack Broughton, ed. (1994). *Institution of Chemical Engineers* (contact details above). Hbk, 282p. ISBN 0-85295-322-4.

Standard Handbook of Plant Engineering

With contributions from more than 70 specialists, this edition of the *Standard Handbook of Plant Engineering* offers a wide range of information on efficient, cost-effective plant engineering – from construction to internal operation, main-

tenance and management of plant facilities. Subjects covered include: using electric power; heating, ventilating and air conditioning; mechanical power transmission; hydraulic and pneumatic systems; piping and valving; pollution control and waste disposal; plant safety and sanitation; maintenance and repair technology; lubrication systems; and materials corrosion.

2nd edition, Robert C. Rosaler, ed. (1994). McGraw-Hill, Inc., 1221 Avenue of the Americas, New York, NY 10020, USA; McGraw-Hill Book Company Europe, Shoppenhangars Road, Maidenhead SL6 2QL, UK. Tel: +44 (1628) 23432, Fax: 35895. Hbk, 1584p. ISBN 0-07-052164-6. £89.95

Explosions in the Process Industries

Potential for explosion in the process industries is considerable. Pressure vessels can fail explosively due to overpressurization, or a cloud of flammable vapour can be accidentally released and ignited. Engineers strive to prevent such events from happening, but it is a vital element of planning to know what may happen when an

explosion occurs. This monograph summarizes what is currently known about explosions in the process industries and the simple methods used to assess their effects. It describes the types of explosion that might occur and how they could cause overpressure and missiles. It shows how people and structures may be damaged and provides methods, first to estimate blast overpressures and missile velocity and second to estimate the degree of injury or damage they might cause. The monograph was prepared by an independent group of British scientists and engineers, the Major Hazards Assessment Panel, but the data presented should be applicable in any country.

2nd edition, (1994). *Institution of Chemical Engineers* (contact details above). Pbk, 74p. ISBN 0-85295-315-1.

Guidelines for Implementing Process Safety Management Systems

This book complements previous work by the Centre for Chemical Process Safety in describing how to undertake the design, development and installation of process safety management systems. The task of process safety management implementation is complex because it crosses over several functional areas of a company's organization. For example, comprehensive process safety management systems influence research, development and engineering; facility and process construction, operation and maintenance; training throughout the organization; procurement; and information management.

(1994). *American Institute of Chemical Engineers, Center for Chemical Process Safety*, 345 East 47th Street, New York, NY 10017, USA. Hbk, 219p. ISBN 0-8169-0590-8, \$120.00.

Guidelines for Safe Automation of Chemical Processes

The chemical industry is becoming increasingly automated with the advent of programmable electronic systems for measurement and control. Whilst increased automation, including alarm systems, controls and interlocks, reduces the potential for operator error, new types of faults can occur in the automated control system. The complexity of computer-based instrumentation systems increases the potential for design and maintenance errors. To ensure a high level of safety, plant management, operations personnel, process specialists, safety professionals, and instrumentation specialists must all collaborate intelligently and with a general knowledge of the key safety philosophies and issues. The goal of this book is to provide the designers and operators of chemical process facilities with a general philosophy and approach to the safe automation of chemical processes.

(1993). *American Institute of Chemical Engineers, Center for Chemical Process Safety* (contact details above). Hbk, 424p. ISBN 0-8169-0554-1

Typical characteristics of industrial wastewater before treatment for selected industry sectors

	Unit processed	Discharge per unit (litres)	Biological oxygen demand (BOD ₅), (mg/l)	Suspended solids (mg/l)
Aluminium and copper	lb	45-50	n/a	300-500
Automotive	car	40,900	190	215
Beverage, malt	bbi	1250	390-1800	70-100
Canning	case	75-150	300-1600	200-500
Fruit		190-380	700-2000	300-2000
Vegetable				
Coal washing	ton	138	n/a	2000-3000
Cooking	ton	1650-3090	50-200	90
Dairy, milk	gal	15-45	1800	560-4000
Electrical	kWh	110	n/a	50-2000
Laundry	ton			
Commercial		36,000	600-1860	400-2200
Industrial		20,000	650-1300	4900-8600
Manufacturing (general)	ton	3000	50-1500	200-15,000
Meat packing	animal			
Cattle		1515-7575	400-900	400-800
Chicken		30-34	150-2400	100-1500
Pigs		1136-2273	1000	650
Office building	person	114-170	117	176
Paint, latex	gal.	11	2000-3000	15,000-60,000
Paper making	lb	108	200-800	500-1200
Pharmaceutical	-	-	600-2500	500-1000
Phenolic resins	ton	31,300	11500	40
Railway maintenance	locomotive	11,360	500-800	200-600
Refining	bbi crude	2900	100-500	300-700
Rubber, synthetic	car tyre	1890	25-1600	60-2200
Steel	lb			
cold-rolled		15	150	100-300
hot-rolled		30	80	500-2000
Tanning, hide	lb	30-45	900	6000
Textiles	lb			
Synthetic		45-95	1500-6000	500
Wool		265	900	100
Vegetable oil	gal.	83	3050	900

Source: Standard Handbook of Plant Engineering

DIRECTORIES & DICTIONARIES

Directory of Environmental Impact Assessment Studies in China

The *Directory of Environmental Impact Assessment Studies in China* is a printout of a computerized database of environmental impact assessment (EIA) studies maintained by the Environmental Systems Information Centre (ENSIC) at the Asian Institute of Technology. Information presented in the directory was collected by the ENSIC focal point in China, the School of Environmental Engineering, Tongji University. The main aim of the EIA database is to assimilate EIA documents from Asian countries, and periodically to publish the directory of EIA studies for the use of local and international consultants, governments and non-governmental agencies, donors, investors and contractors. Most of the records in the directory contain the title of the project or the study, institutions involved, a contact person, the source documents, and subject descriptors. Wherever possible, a summary of the study is given.

(1994). *Asian Institute of Technology, Environmental Systems Information Centre, P.O. Box 2754, Bangkok 10501, Thailand. Tel: +66 (2) 524 5863, Fax 524 5870. Pbk, 155p.* ♦

Environmental Engineering Dictionary

Solving today's environmental problems has required many new environmental regulations and technologies, involving an ever increasing volume of technical terminology. The second edition of this dictionary defines over 12,000 technical and regulatory engineering terms (as used in the US) used in pollution control technologies, monitoring, risk assessment, sampling and analysis, quality control, and environmental engineering and science.

2nd edition, C.C. Lee (1992). *Government Institutes, Inc., 4 Research Place, Suite 200, Rockville, Maryland 20850, USA. Tel: +1 (301) 921 2300. Hbk, 462p. ISBN 0-86587-328-3.* ♦

EDITIONS FRANÇAISES/TITULOS ESPAÑOLAS

Milieux côtiers canadiens, processus littoraux et nettoyage à la suite de déversements d'hydrocarbures

La zone côtière est un milieu dynamique ; il est donc nécessaire, lors de l'élaboration de stratégies d'intervention pratiques et efficaces en cas de déversement, de comprendre les forces qui contribuent aux processus littoraux. Les côtes canadiennes comptent une grande variété de milieux, allant du 45^e parallèle Nord à l'Extrême-

Arctique, caractérisés par divers type de littoraux, notamment les falaises résistantes exposées de la partie est de Terre-Neuve et les marais abrités de la mer de Beaufort ou du lac Huron. L'approche adoptée dans le présent rapport vise à faire comprendre la dynamique et les processus physiques propres aux différentes côtes du Canada, y compris celles des Grands Lacs. Un aperçu régional du caractère général et des processus fournit une description des milieux côtiers et une introduction à la documentation que l'on peut consulter pour obtenir plus d'information sur un site ou un sujet donné. On y traite du devenir probable et de la persistance des hydrocarbures qui atteignent le littoral afin de fournir un cadre nécessaire à l'élaboration de stratégies d'intervention et au choix de mesures appropriées de nettoyage ou de traitement du littoral.

Série de la protection de l'environnement, E.H. Owens (1994). Environment Canada, Service de la protection de l'environnement, Ottawa, Canada K1A 0H3. Pbk, 352p. ISBN 0-662-99882-0, ref: En49-14/3-5F, rapport : SPE 3/SP/5. ♦

Bases para una Política Nacional de Residuos Peligrosos

El objetivo de esta publicación es aportar información actualizada para una discusión productiva sobre la problemática que representan en México los residuos peligrosos. A fin de consolidar un modelo de desarrollo sustentable que no ponga en riesgo los recursos naturales de los que dependen las generaciones futuras, nuestro país necesita atender en forma mucho más efectiva la reducción y el manejo de los residuos peligrosos. Este problema representa un reto de enormes dimensiones no sólo con relación a la contaminación ambiental y los riesgos a la salud, sino incluso en términos del desarrollo económico y la reconversión industrial, la integración de políticas sectoriales, la información y la participación pública.

(1994). *Secretaría de Desarrollo Social, Av. Constituyentes 947, 01110, México, D.F., México. Cubierta blanda, 38p. ISBN 968-838-335-X.* ♦

JOURNALS/NEWSLETTERS

New Zealand Environmental Law Reporter

The Environmental Law Centre, which publishes this newsletter, was established in 1993, with the objectives of improving the quality of New Zealand's environmental laws and regulations, and of promoting public participation in environmental decision making. *New Zealand Environmental Law Reporter* contains updates on environmental legislation in the country, court cases relating to environmental law, environmental activities undertaken by local authorities, and points of view on environmental law issues. The newsletter also contains a column on Pacific legal developments.

Published four times a year by The Environmental Law Centre Inc., P.O. Box 2579, Shortland Street, Auckland, New Zealand. ISSN 1173 0528. ♦

ICME Newsletter

The International Council on Metals and the Environment (ICME) was established in mid-1991 to bring together major nonferrous and precious metal mining and primary metals companies on a worldwide basis. The *ICME Newsletter* aims to present ICME's views on key environmental issues and to publicize ICME members' environmental activities and achievements. The first issue of the newsletter includes a reproduction of the ICME Environmental Charter, containing environmental and product stewardship principles for the mining industry.

Published four times a year by the International Council on Metals and the Environment, 360 Albert St, Suite 1550, Ottawa, Canada K1R 7X7. ♦

Safety and nutrition adequacy of irradiated food

Food irradiation has, in certain circumstances, an important role to play both in promoting food safety and in reducing food losses. The World Health Organization is concerned that the unwarranted rejection of this process, often based on lack of understanding of what food irradiation entails, may hamper its use for food processing in those countries which are likely to benefit most.

WHO actively encourages the proper use of food irradiation in the fight against foodborne diseases and losses, and recently published an up-to-date report on food irradiation. Scientific studies carried out since 1980 have been reviewed and evaluated in its preparation. The following is an executive summary of this report.

Applications

Food irradiation can have a number of beneficial effects, including delay of ripening and prevention of sprouting; control of insects, parasites, helminths, pathogenic and spoilage bacteria, moulds and yeasts; and sterilization, which enables commodities to be stored unrefrigerated for long periods.

The shelf-life of many fruits, vegetables and meats can be extended by irradiation. Sprouting in root crops such as potato, sweet potato, yam, turnip, carrot, onion, garlic, shallots, beets, and Jerusalem artichoke can be inhibited with irradiation doses of 0.05-0.15 kGy. Irradiation of tropical and sub-tropical fruits such as bananas, mangoes, papayas and guavas at doses of 0.25-1 kGy delays maturation and senescence. Ripening is suppressed in temperate-zone fruits such as apples, pears and stone fruits at doses in excess of 1 kGy, although this often results in some damage to the fruit. Mushrooms irradiated at doses up to 1 kGy may have their shelf-life extended by as much as five to seven days. Strawberries are relatively resistant to damage by ionizing radiation, and irradiation at 2-2.5 kGy in combination with refrigeration can increase shelf-life by one to two weeks.

Levels of spoilage bacteria in poultry may be reduced sufficiently to prolong shelf-life by as much as one to two weeks following exposure at 3 kGy. Most of the spoilage organisms in meats can be killed by sub-sterilizing doses of ionizing radiation, resulting in a significant extension of shelf-life. Many meats can tolerate relatively high doses of irradiation if appropriate precautions are taken. For example, blanching, freezing and the exclusion of oxygen together with doses in the 25-45 kGy range can result in sterilized food with a long shelf-life. Sub-sterilizing doses of ionizing radiation can also extend the shelf-life of fish and shellfish.

Many important fresh fruit and vegetable pests, including fruit flies, the mango seed weevil, the navel orange worm, the potato tuber worm, the codling moth, spider mites and scale insects, may be controlled by doses of 1 kGy or



less. Insect disinfestation of nuts and dried fruits can also be achieved, since most insects are killed by doses in the range 0.25-0.75 kGy.

Spices and related materials may contain large amounts of moulds, bacteria, and their heat-resistant spores. Doses of 3-10 kGy can significantly improve the hygienic quality of spices, dehydrated vegetables, herbs, and other dry ingredients. Doses of 1 kGy or less can prevent losses from insect infestation in stored grains, pulses, flour, cereals, and coffee beans.

Much of the raw poultry sold for human consumption is contaminated with *Salmonella* and *Campylobacter*, both of which can be effectively controlled by irradiation, as they are readily destroyed by doses in the range 2-3 kGy. Irradiation of pork at doses of 0.3 kGy or less can kill the larvae of the parasite *Trichinella spiralis*, and low-dose irradiation may also reduce the risk of cysticercosis caused by the pork tapeworm. Infections resulting from the consumption of undercooked beef containing beef tapeworm cysts may be prevented by irradiation at a minimum dose of 0.4 kGy.

It is most unlikely that all these potential applications will prove commercially acceptable; the extent to which such acceptance is eventually achieved will be determined by practical and economic considerations.

Chemistry

There are many forms of radiation, but only high-energy radiation can produce ions or charged particles after being absorbed by matter. This type of radiation is called ionizing radiation, and comprises gamma rays from decaying radioisotopes, X-rays, and machine-generated electrons. Absorption of ionizing radiation by food molecules results in the breaking of chemical bonds and the generation of free radicals and charged ions, leading to the formation of radiolytic products. The study of the chemistry of food irradiation has largely focused on the nature of these products.

Each of the three major macronutrients in food - carbohydrates, proteins and lipids - gives rise to different types of radiolytic products when exposed to ionizing radiation. Water plays a key role in influencing the nature and yield of

the products from carbohydrates which, in the presence of water, react chiefly with hydroxyl radicals, producing ketones, aldehydes and acids. Sugars are also formed from starches. Amino acids undergo reactions including abstraction of hydrogen, reductive deamination, disproportionation, decarboxylation, and reaction of intermediates with the highly reactive products of water radiolysis. When proteins are irradiated in the presence of water, all the reactions that amino acids undergo may also take place in proteins containing these amino acids. As a result, large numbers of different radiolytic products may be formed. Degradation of proteins to smaller polypeptides may occur, but aggregation of proteins is also possible. In a food matrix, the amino acids contained in a protein are much less subject to attack than in pure solution because they are relatively inaccessible. In contrast to carbohydrates and proteins, the irradiation chemistry of lipids does not involve water, as they are virtually insoluble. A wide range of radiolytic products may be formed, including fatty acids, esters and diesters, aldehydes, ketones, alkanes and alkenes, diglycerides and shorter-chain triglycerides. In a meat matrix, oxidative changes in lipids are relatively minor because of possible antioxidant effects of proteins with increasing radiation dose. It is important to emphasize that, while a wide range of radiolytic products may be formed in the three major macronutrients, with good manufacturing practice radiation affects less than 1-2% of the macronutrients in food.

The study of chemistry of the effects of irradiation on vitamins has focused chiefly on the extent of nutrient loss. In pure solution, vitamin destruction is far greater than that observed in foods. With some exceptions, the destruction of vitamins caused by the irradiation of food is relatively small, resulting in little change in overall nutritional value. The extent to which vitamins are lost through irradiation depends on both food type and storage conditions.

There has been much discussion over whether irradiation of foods produces unique radiolytic products, i.e. compounds not found in foods either in the natural state or as a result of conventional food processing. As it will be difficult to establish that such products exist, concern about their toxicological potential is speculative.

The United States Army has produced detailed analysis of 65 volatile chemicals in irradiated beef. Also in the United States, the Food and Drug Administration (FDA) reported that six of these chemicals could not be identified in volatile fractions of non-irradiated foods, and therefore suggested that they might be unique. Further investigation showed that only three of the six (undecyne, pentadecadiene, hexadecadiene) had not been found in non-irradiated foods. These chemicals are not unusual: compounds differing from them by only one carbon atom have been detected in non-irradiated foods. The existence of such very close homologues suggests that the three apparently unique

Sections

radiolytic products probably exist at some level in non-irradiated foods, and might be found if more sensitive analytical techniques were to become available. In the same way, more sensitive analytical techniques might eventually reveal the existence of unique radiolytic products at extremely low levels.

The example cited above concerns reaction products associated with a volatile fraction, and this is probably typical of the relationship of non-volatile radiolytic products and possibly of unique radiolytic products to one another, and to radiolytic products that are constituents of non-irradiated foods. Whether radiolytic products are unique or not, enzymatic hydrolysis would be expected to transform most of them into common compounds, such as fatty acids, amino acids, monosaccharides, and other products resulting from the human digestive process.

All foods are to some extent radioactive, generally at extremely low levels. There is some concern that irradiation of foods may result in induced radioactivity. Based on worst-case assumptions, the estimated induced radioactivity would be considerably below the level occurring naturally in food; irradiation in the commercially useful range is not expected to generate measurable additional radioactivity in foods.

Nutrition

Among the most important issues to be considered in assessing the acceptability of irradiated foods is whether such foods are nutritionally equivalent to those processed by traditional means. Food irradiation can cause changes in

both macro- and micronutrients, but these changes are small. Irradiation is not alone in its ability to produce nutritional changes. Many food processes, notably cooking and heating in general, also cause nutrient loss, often to a greater extent than irradiation. The energy value of foods depends on the proteins, carbohydrates and fats in them. At irradiation doses up to 10 kGy, no significant destruction of these macronutrients has been observed. While chemical analyses do show effects with doses up to and including sterilizing doses (50 kGy), they are small and non-specific.

The view that irradiated foods are generally nutritionally equivalent to non-irradiated foods subjected to normal processing is supported by many animal studies, including some in which the protein efficiency ratio for many irradiated high-protein foods was measured. Proteins are of special concern, as they provide essential amino acids needed by the body to build its own protein. No significant effects on essential amino acids have been observed in beef, fish, or many other foodstuffs, in some cases at sterilizing doses.

The effect of irradiation on vitamins varies depending on the food type, the vitamin in question, and the process and storage conditions. Some vitamins are fairly insensitive to irradiation; others are more easily destroyed. The importance of a vitamin loss in any particular food depends on the contribution of that food to the total diet. For example, loss of vitamins from spices would not be a cause for concern, but loss of thiamine (vitamin B₁) from pork could be detrimental to populations where pork is an important component of the diet.

There is no loss of minerals and trace elements as these nutrients are unaffected by irradiation.

Irradiation temperature, exposure to air, and storage conditions may all affect nutrient content. In many cases, low-temperature irradiation in the absence of oxygen helps to reduce any losses of vitamins in foods, and storage of irradiated foods in sealed packages at low temperature also helps to prevent future decomposition.

Conclusions

A review of the available scientific literature indicates that food irradiation is a thoroughly tested food technology. Safety studies have so far shown no deleterious effects. Irradiation will help to ensure a safer and more plentiful food supply by extending shelf-life and by inactivating pests and pathogens. As long as requirements for good manufacturing practice are implemented, food irradiation is safe and effective. Possible risks resulting from disregard of good manufacturing practice are not basically different from those resulting from abuses of other processing methods, such as canning, freezing and pasteurization.

Source: Safety and Nutritional Adequacy of Irradiated Food, World Health Organization (WHO), CH-1211, Geneva 27, Switzerland (1994).

AWARE is prepared and published in collaboration with UNEP's International Register of Potentially Toxic Chemicals (IRPTC). Comments on the present series of AWARE articles are welcome and should be sent directly to UNEP/IRPTC, Palais des Nations, CH-1211, Geneva 10, Switzerland. ♦

Climate change issue

Thank you very much for the special edition of *Industry and Environment* dealing with climate change. I am very pleased that we in the UNEP Atmosphere Unit could be a part of the production.

The issue is timely, thoughtful and very attractively presented. You have gathered together some excellent writers on topics which are essential to address if the Framework Convention on Climate Change is to develop the muscle for effective greenhouse gas emissions reduction.

I liked the article by Jeremy Leggett of Greenpeace on the insurance industry awakening to the new risks for both the climate vulnerable and those that underwrite the risks. The insurance industry is an audience that we are also targeting amongst other users of climate information in a series of workshops on "Usable Science".

The interview with Michael Jefferson of the World Energy Council clearly outlined the challenge for energy suppliers. It is also most useful to have a set of articles on abatement strategies and technological developments together in a volume that can be easily referenced.

My congratulations on a first-class product.

Peter Usher
Chief, Climate Unit
UNEP
P.O. Box 30552
Nairobi
Kenya

Recycling in Manila

Thank you for sending us your magazine. It is very educational and stimulating, and we are translating many of the articles into Filipino for the magazine of the Metro Manila Council of Women Balikatan Movement, *Ang Philipina*.

In the context of your two *Industry and Environment* issues on recycling, we would like to tell your readers what we are doing through the Metro Manila Resource Recovery Programme to clean Metro Manila of its garbage.

Metro Manila's 8 million residents live in five cities and twelve towns, and produce about 3500 tonnes of waste every day. Many residents throw garbage carelessly in the streets and canals, which returns to them through the water they drink, the air they breathe and the seafood they eat. The government can be faulted, too, for irregular collection of waste and its insistence on dumping and incineration, however and wherever. As a result, the Pasig River has been turned into a garbage refuge, as have the San Juan and Marikina Rivers. Leachates from the open dumpsites around Metro Manila get into the water system, while residents breathe the methane gas emitted by the dumpsites.

The Metro Manila Resource Recovery Programme was launched to address these problems. Through the Programme, junk shop



owners in each Metro Manila town have been formed into environment cooperatives to organize the collection of recyclable wastes from households. Nearly 900 junk shop owners are involved in the programme, in turn employing more than 1500 "eco-aides" who collect wastes such as paper, plastics, bottles, cans and car batteries from households.

We have given each participating junk shop green-painted push carts or bicycles with side cars; green t-shirts for the eco-aides (see photo), and ID cards for the eco-aides and junk shop owners. We also prepared weekly collection routes for each eco-aide. Eco-aides pay householders for material collected, which they sell on to the junk shop owners. This gives the eco-aides a daily income, which can be substantial: from a minimum of P 100 (US\$ 5) to P 300. The junk shop owners sort the resources and sell them to paper, plastics, bottles and can factories, which, through the Programme, have arranged to make systematic purchases of recyclable resources.

This system reduces the pressure on the dumpsites by at least 60-70 per cent. And it makes for sustainable development. Fewer trees are cut when used paper is returned to the factories; less oil is pumped when plastics are re-used; less silica is mined when broken bottles are returned to the glass factories; less iron ore is mined when cans are melted into ingots and used again.

During 1995, we plan to make several improvements to the Programme. We shall build ten plants to produce charcoal from garden refuse, coconut shells and wood construction debris. The first rubber shredders for items such as rubber shoes should become operational. Old motor tyres are to be collected by Metro Manila's three tyre factories. Digester tanks are to be built in ten meat markets to convert animal wastes into methane, which will be used by the slaughterhouses as an energy source.

We are still researching what to do with disposable cigarette lighters, cameras, small batteries, transistor radios, disposable sanitary napkins and diapers, millions of ball-point pens, and upholstery. Meanwhile, we are campaigning to ask everyone to first reduce their garbage and to reuse things before recycling. We expect the Metro Manila Resource Recovery Programme to reach all 1.5 million households in Manila by 1996, and we believe that the entire waste stream can be recycled in time.

Leonarda N. Camacho
Chairperson
Metro Manila Council of Women
Balikatan Movement, Inc.
215 Regency Park
207 Santolan Road
Quezon City 1100
Metro Manila, Philippines
Tel: +63 (2) 797 230.



Recycling household waste in Manila, the Philippines

5ème Conférence Internationale Villes et Ports

DAKAR, 22/25 novembre 1995

COMMUNIQUE DE PRESSE

Tous les indicateurs économiques témoignent aujourd'hui d'un développement vigoureux du commerce mondial. 1994 aura ainsi été l'année d'un nouveau record pour le trafic maritime mondial avec 4.475 millions de tonnes transportées. En près de vingt ans, les tonnages acheminés sur les mers et les océans du globe ont progressé de près de 50 %.

Les villes portuaires du monde entier sont des maillons essentiels dans la circulation des biens et des services. Elles doivent leur richesse et leur développement au transport maritime et fluvial. Pour autant, de nombreuses villes portuaires historiques ont été frappées de plein fouet par la crise économique mondiale qui a parfois profondément bouleversé leurs structures économique, sociale et urbaine.

Les villes portuaires doivent aujourd'hui répondre à un triple défi:

- ♦ intégrer la fonction portuaire au dynamisme urbain qui fait une place de plus en plus large aux impératifs de qualité de vie ;
- ♦ saisir les nouvelles opportunités liées au trafic portuaire pour diversifier et réaffirmer leurs vocations économiques spécifiques ;
- ♦ développer un aménagement soucieux de prévenir les risques et les nuisances par la concertation entre tous les partenaires.

Pour réussir ce triple défi, les villes et les ports doivent s'intégrer plus efficacement dans les logiques d'aménagement du territoire nationales ou continentales. La 5ème Conférence Internationale Villes et Ports qui se tiendra à Dakar (Sénégal) du 22 au 25 novembre 1995 permettra aux décideurs des villes et des ports de faire le point sur les nouvelles stratégies à mettre en oeuvre, sur les méthodes de travail qu'il convient désormais d'adopter pour redonner aux villes portuaires la place qui leur revient dans le développement des territoires et l'espace économique international.

Dans le prolongement des travaux de la conférence internationale de Montréal organisée en 1993 par l'AIVP, s'appuyant sur la « Charte des villes et des ports pour l'environnement » qui y fut adoptée, les villes et les ports doivent continuer à travailler ensemble, à imaginer ensemble la ville portuaire durable de demain.

Le PNUE a accordé son patronage à cet événement et fera une présentation sur le thème « gestion environnementale des zones industrielles portuaires et prévention des accidents technologiques dans les ports ».

THE ROLE OF UNEP INDUSTRY AND ENVIRONMENT

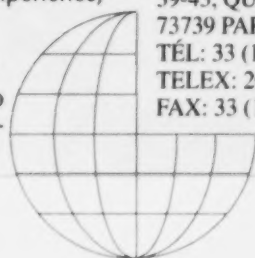
It is now widely accepted that sustainable development and a sound environment go hand-in-hand. UNEP recognized this as early as 1975 when it established the Industry and Environment centre (IE), located in Paris. UNEP IE functions as a catalyst to bring industry, government and non-governmental organizations together to work towards environmentally sound forms of industrial development. UNEP IE seeks to:

- ◆ define and encourage the incorporation of environmental criteria in industrial development;
- ◆ help formulate policies and strategies for sustainable industrial development and facilitate their implementation;
- ◆ promote preventive environmental protection through cleaner production and other pro-active approaches; and
- ◆ stimulate the exchange of information on environmentally sound forms of industrial development.

To achieve these goals, UNEP IE has developed programmes in the fields of Awareness and Preparedness for Emergencies at Local Level (APELL), Cleaner Production, Tourism and Transport and other sector-specific activities. UNEP IE organizes conferences and seminars, undertakes training activities and demonstration projects, and produces practical supporting publications.

To promote the transfer of information and experience, UNEP IE has developed:

- ◆ The *Industry and Environment* quarterly review;
- ◆ A *Query-Response Service*, which responds to specific technical queries on a wide range of subjects related to industrial pollution;



◆ *Outreach Activities*, which address a broad range of issues concerning industry as a whole. UNEP IE develops partnerships with industry, government and non-governmental organizations, organizes consultative meetings and publishes supporting documents aimed at spreading new developments in the field of sustainable development.

◆ A *Technical Report Series* and other publications provide practical information to readers throughout the world. Recent titles include *Cleaner Production Worldwide*, *Hazards Identification in the Local Community*, *From Regulations to Industry Compliance: Building Institutional Capabilities*, *Audit and Reduction Manual for Industrial Emissions and Wastes*, *Companies Organization and Public Communication on Environmental Issues* and many others. For a complete list of available publications, please contact UNEP IE.



UNEP

UNITED NATIONS ENVIRONMENT PROGRAMME
INDUSTRY AND ENVIRONMENT

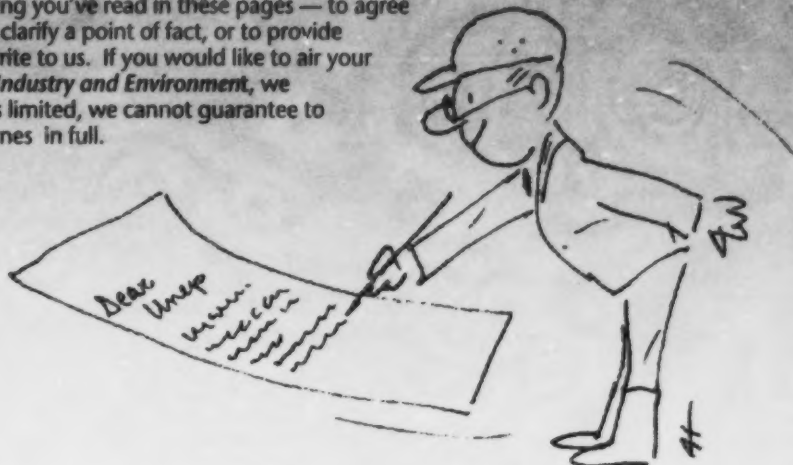
39-43, QUAI ANDRÉ CITROËN
75739 PARIS CEDEX 15 FRANCE
TÉL: 33 (1) 44 37 14 50
TELEX: 204 997 F
FAX: 33 (1) 44 37 14 74

FEEDBACK

If you would like to respond to something you've read in these pages — to agree or to take issue with a point of view, to clarify a point of fact, or to provide information on a particular aspect — write to us. If you would like to air your views on any other subject relevant to *Industry and Environment*, we would like to hear from you. As space is limited, we cannot guarantee to publish all letters, nor to publish long ones in full.

Send your Feedback letters to:

Feedback
Industry and Environment Review
UNEP IE
Tour Mirabeau
39-43, quai André-Citroën
75739 Paris Cedex 15, France
E-mail address: unepie@unep.fr



Industry and Environment Review

a publication of the United Nations Environment Programme
Industry and Environment – UNEP IE

For more than fifteen years, the *Industry and Environment* quarterly review has provided a forum for the exchange of research and experience, presenting articles written by and for industry managers, government officials and researchers in the field of sustainable industrial development. In addition to features, news and developments of broad international interest, each issue of the review focuses on a particular theme. Recent issues have covered such varied topics as climate change and industry, education and training, managing contaminated land, transport, and sustainable tourism development. For a complete list of past issues and their availability, contact UNEP IE.

The next issue of *Industry and Environment* will focus on the themes of environmental management tools for industry and environmental technology assessment.

While *Industry and Environment* is an English language publication, it also includes articles in French and Spanish. All contributed articles are preceded by summaries in English, French and Spanish.



环境署

The review is now also available in Chinese translation. For further details, please contact: Professor Chen Dingmao, Research Center for Eco-Environmental Sciences, Academia Sinica, P.O. Box 2871, Beijing 100085, China.

INDUSTRY AND ENVIRONMENT SUPPLEMENTS

The *Industry and Environment* review includes three semi-annual supplements, the *APELL*, *Cleaner Production* and *EnTA* newsletters.



UNEP IE's APELL programme – Awareness and Preparedness for Emergencies at Local Level – seeks to minimize the occurrence and impact of industrial accidents. This newsletter keeps readers up-to-date on APELL programmes currently in progress around the world.



The Cleaner Production newsletter provides information on cleaner technologies and products, actions by governments and organizations to promote cleaner production, and the UNEP IE Cleaner Production activities and network.



The EnTA newsletter reports on technology assessment as a tool to develop environmentally sound technologies and to discourage the export of those that pose potential environmental hazards.

INDUSTRY AND ENVIRONMENT SUBSCRIPTION ORDER FORM

Name: _____ Date: _____
Title: _____
Department: _____
Organization: _____
Address: _____
Annual subscription: Surface mail US\$45.00 ☐
Air mail US\$60.00 ☐

Note: Institutions and public libraries may request billing. Commercial firms and individuals, please send payment along with order form.

• **Payment can be made as follows:**

Send cheque in US\$ to the order of: United Nations Publications
or Transfer payment to: Société de Banque Suisse, Geneva - Acct. N° CO-590, 159-1 - UNOG Sales of Publications
or Transfer payment to: Swiss Postgiro 12-1078-3

Please send your order to: UN Bookshop/Sales Unit - Palais des Nations - CH-1211 Geneva 10 - Switzerland
with copy to: UNEP IE, Tour Mirabeau, 39-43 quai André-Citroën, 75739 Paris Cedex 15, France